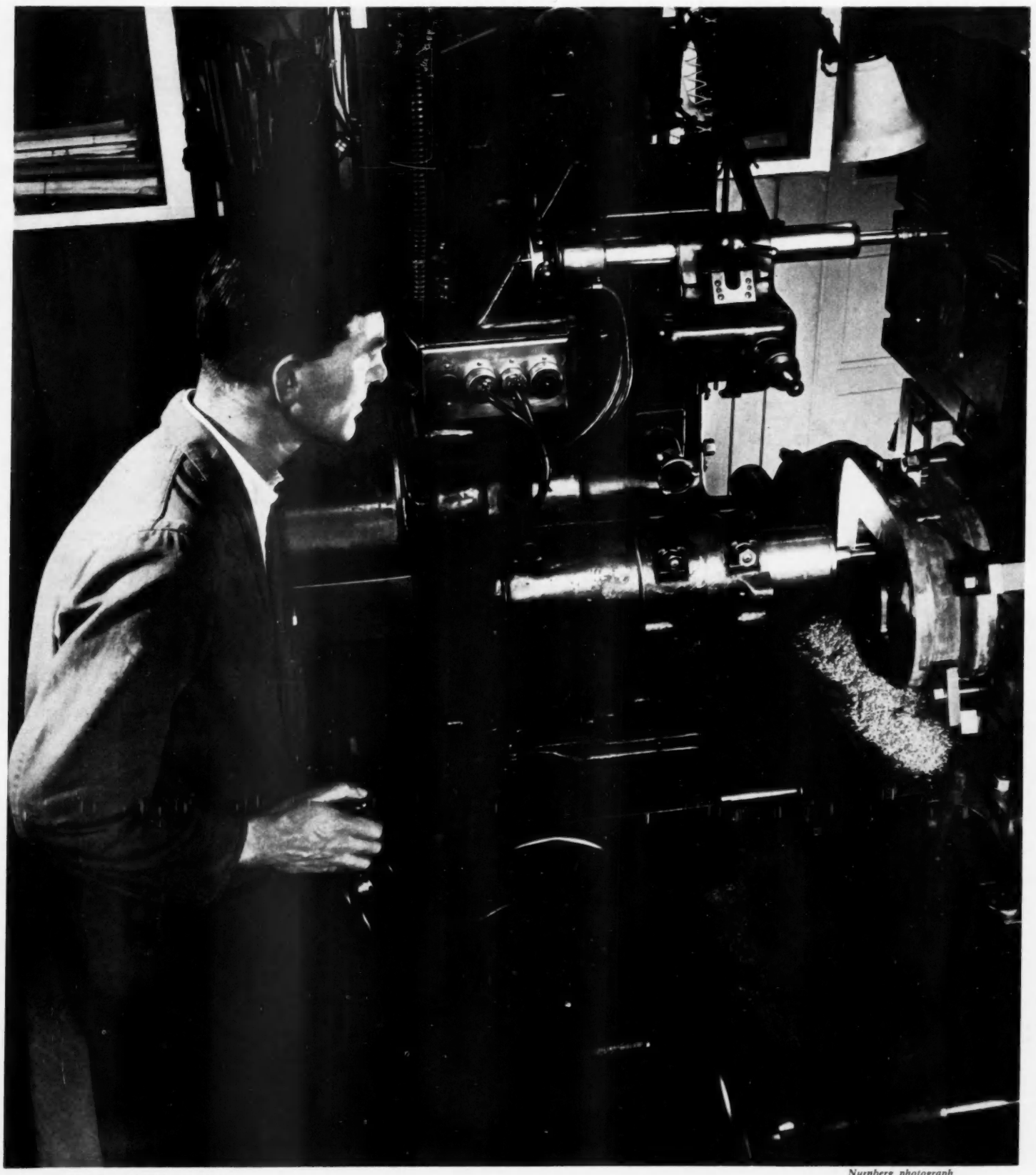
ENGINEERING 31-5-57 7

ENGINEERING

An Illustrated Weekly Journal

35 & 36 BEDFORD STREET, STRAND, LONDON, W.C.2 - - TELEPHONE: TEMPLE BAR 3663

Vol. 183 No. 4760 *LONDON, FRIDAY, MAY* 31, 1957 PRICE 2s.



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Nurnberg photograph for ENGINEERING

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Published every Friday by Engineering Limited, 35 & 36 Bedford Street, Strand, London, W.C.2 TELEGRAPHIC ADDRESS *Engineering, Lesquare, London* TELEPHONE *Temple Bar* 3663.

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Subscription Rates for 12 *months, Inland and Abroad* £5 10*s.*, *Canada* £5 5*s. Subscriptions for periods of less than* 12 *months are based on the price of a single copy including postage* (2*s.* 3*d.*)

AMERICA'S "ANGST"

In the middle of the Nineteenth Century British businessmen were self-confident, adventuresome and aggressive. By the end of the century the combined effects of rising competition from more modern industries abroad and a growing guilt feeling about the unpleasant by-products of the industrial revolution at home had largely destroyed the self-confidence and the drive, and the sons of the founders of Britain's industrial greatness reclined on the plush feather-beds of the Edwardian era. In the United States of America an even greater self-confidence and a ruthlessness uninhibited by aristocratic traditions of paternalism led, by the late 1920's, to a rise in the output of goods and services unprecedented in world history and put its fortunate beneficiaries in a position of material comfort which is likely to remain ahead of that of other nations for many years to come. There are signs, however, that the sublime self-confidence which has for so long supported American businessmen and industrial leaders may be evaporating and that it is being replaced by doubts and anxieties which, on the face of it, seem to have little to do with their proper task of making and selling goods.

A recent collection of essays, re-published from the *Harvard Business Review*, reflects these anxieties in face of an expressed conflict of outlook between management and union spokesmen which far exceeds anything that has been expressed by responsible leaders on both sides in Britain. In may be that when American businessmen take to print they express ideas which do not reflect their current business behaviour, but in that case these essays are at least a portent.

It is a characteristic of Americans that they seek for a single unifying moral purpose to any activity, whether in the world of politics or business, and are worried by the conflicts which are the inevitable concomitants of modern industrial life. They want also, more than most people, to be accepted by the groups in which they live and work and to be loved by all those with whom they associate. It is this characteristic which aggravates the present dangers of conformism in the United States, but which also creates anxiety when the divergent ideals of the different groups to which a person may belong—in work, in trade union, in community, in church or in politics—are in conflict.

On top of all these conflicts, inherent in modern society, the American businessman thinks he faces a challenge to his very *raison d'etre*—not only from Communism but also from the changing nature of capitalism itself, with its absentee ownership and central economic planning agencies, both public and private. He tends, therefore, to believe that, in writing about management methods, and particularly human relations, he has to be an evangelist for the free enterprise system and to proclaim a philosophy which is more than a system of business management, but is a whole way of life. Unfortunately, he is rarely a clear-headed philosopher and he finds it difficult to accept the contradictions which must accompany a system of industrial organisation which has existed for a bare two or three hundred years and is radically different from anything human beings had previously experienced.

The result is often a spate of verbosity which must make more difficult the task of management students in facing up to the realities of their age; one of which, as Lord Halsbury has recently pointed out in a stimulating article in the Unesco publication *Impact of Science on Society*, is that managers are relatively free in their work while workers are relatively under compulsion. It is perhaps because of management's refusal to accept the existence of such incompatible positions that the number of days lost by strikes in the United States is something like ten times what it is in this country. Although it is also necessary to remember that the pressure of the trade unions for higher wages, especially in a country whose economy is not complicated by the need to export, is a very potent force causing the introduction of better manufacturing methods.

It is because of this evangelistic approach to business management that so much of the work of American "human relations" experts is devoted to the recording and discussion of detailed case studies of minor personal situations and the attempt to distil from them a technique for getting the worker to accept the philosophy of management—an activity which by generating hostility in trade unions only widens the gap between them and management. By comparison British management is practical and pragmatic; not so much concerned with theories and philosophies as with ways to come to terms both with the mixed economy which is typical of most modern industrial states and with the inevitable conflicts which it meets on the shop floor. This is not to say that there is not, in this country, a growing interest in management methods, but this takes its place with the re-awakened interest in

An important announcement about articles submitted to "Engineering" for publication appears on page 686 of this issue.

scientific research and technological change for which new methods of training are required.

It may well be that we are seeing the beginning of a reversal of the psychological roles played by British and American businessmen during this century; the former regaining something of their old initiative in the search for new products, new markets and new methods; while the latter become absorbed in introspective analysis of the reasons for their existence and in anxious study of the opinions in which they are held by their neighbours.

Human Relations for Management. Edited by Edward C. Bursk. Constable & Company Limited, 10 Orange-street, London, W.C.2. (27*s.* 6*d.*)

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Plain Words

In a democracy the role of the opposition, official or otherwise, is often so powerful that it can scotch schemes which are of obvious social benefit. It only needs a proposal to build an atomic power station, or a new college, or a road that goes through sacred ground, or to reconstruct a bridge that everyone thought was perfectly adequate, for a storm of protest to blow up. Sometimes the blowing comes from private citizens whose properties seem likely to be devalued, and sometimes it comes from the sincere champions of art (usually supported or embarrassed by a number of bright old things who want to cash in on a little publicity). Why is it that no-one ever thinks of organising a campaign to give support to projects of this kind? Why is it that no common man, writing from "Chez Nous," springs to the support of the Ministry of Transport, whose scheme for a new trunk road may cut his commuting time by five minutes? It seems that we are all very ready to resist a wrong, an injustice or a hardship, but we are quite neutral, even lethargic, when people set out to benefit us.

There is a point at which the public interest outweighs the individual's claims, even in a democratic country, for we all have a part share in the public good, whether we recognise it or not. In the last 20 years, experience of totalitarian states has led us to over-compensate, to recoil from any suggestion of public authority as if it served some alien interest, rather than our own. But to-day we are learning slowly how sectional claims of doubtful justice can deprive a much greater number of their legitimate rights—their means of travelling to work perhaps, their daily papers, even their meat, fish or livelihood.

Long ago, it seems, one of the atomic energy constructional groups undertook to build in Scotland the world's largest nuclear power station, a project imaginative in conception and rich in promise. A militant opposition immediately arose like a conditioned reflex, and the inquiry is now approaching its six month under a second president. It would not be surprising if some astute German or Japanese offered to take this apparently unwelcome station off our hands. But fishing rights must be guarded, the view must not be spoiled, even if the lights of four million people in greater Glasgow begin to flicker and work at Clydebank stops.

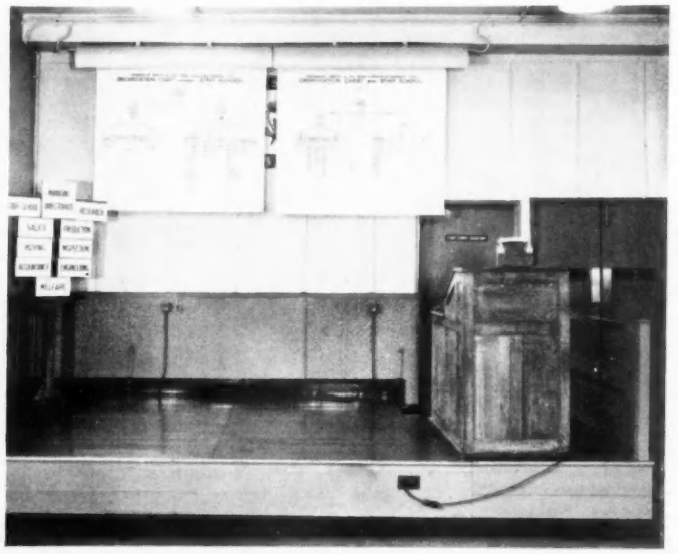
The reason for the situation is obvious. The disadvantages of any scheme of this kind are localised and concentrated and a protest is easy to organise, but its rewards are diffuse and wide. It seldom occurs to the soldier who appropriates army stores that he is stealing from himself and his pals, but he is quick to grumble if the army subtracts a penny from his pay to subsidise some common benefit. It is time we stopped smiling or shrugging, or even cheering, when some clown chops down our, OUR, electricity transmission towers. We are fighting a battle; and we are all on the same side.

THE ROAD TO THE TOP

In those companies which have developed an articulate system by which managers are found and trained, there are beginning to emerge three distinct phases in the process. The first is that of selection, either from within the organisation or from outside. The sophistication of the techniques used for this purpose varies greatly. For instance, of a sample of 112 firms in the north-west of England surveyed for a recently published report only 37 had pre-determined standards and qualifications for management jobs or used a systematic interview technique.

Of the firms, 61 per cent. claimed that they maintained inventories of their management requirements, but the authors of the report doubt the effectiveness of many of them although some of the larger firms have established special machinery for ensuring that adequate provision is made for management succession. Joseph Lucas, for instance, has set up an executive development steering committee consisting of the personnel director, deputy managing director and vice-chairmen of all the subsidiary companies. At Baker Perkins, each of the five members of the board of management makes an annual report to the board on the progress, development and potentiality of every member of the departments for which he is functionally responsible, with the names of the most probable successors to every post. The National Coal Board has recently established a staff-planning branch for this purpose. Many companies use their superannuation schemes to estimate the vacancies that will arise in the management chain, although this hardly seems a suitable method in a company subject to rapid expansion or change.

Systematic training for management posts is still much less practised in this country than in the United States. It is not simply that the technical college courses in management studies and the resultant diplomas have not achieved the recognition it was hoped they would, chiefly because of the inadequacy of much of the teaching, nor the failure of our universities to provide courses either at undergraduate or post-graduate level. In fact, although business management courses are still as popular as ever among students in the United States, employers no longer look to them as the main source of management potential. More and more it is becoming recognised that systematic training must be provided within the company itself and that this training may have to continue at intervals during the rising manager's industrial life. If the second phase of management recruitment is, therefore, the initial training of the new entrant, whether he comes from within the firm



Staff colleges for training future managers are not confined solely to large firms and nationalised industries. Frederick Smith and Co., wire makers, Halifax, use their school for all levels of staff training, including keeping top management abreast of new ideas. Considerable use is made of visual aids.

In the largest firms, such as American G.E.C., formal lectures making use of printed notes are possible, with many potential managers taking part simultaneously.

or direct from the university, the third is what is becoming known as executive development and may well continue until, or even after, the manager has reached the board or, in American terms, become a vice-president.

It is generally recognised that an important part of early management training is rotation between a number of jobs involving direct responsibility in different fields; but, with the growth in the size of undertakings, some more formal training is now felt to be necessary. To some extent the requirements of this latter phase are covered by courses run by external bodies such as the universities or the various organisations associated with management. In this country there are the Administrative Staff College at Henley, the Business Management Schools conducted annually at the Universities of Oxford and Cambridge, the executive development courses and special conferences of the British Institute of Management, as well as the *ad hoc* courses and conferences of such bodies as the professional engineering institutions and the Institute of Personnel Management and the Industrial Welfare Society. In the United States the universities have been unable to cope with the growing requirements of industry for this sort of training and it seems as if the provision is inadequate in this country, for more and more large companies are beginning to provide their own facilities including, in many cases, a residential school.

Companies with widespread international responsibilities are naturally concerned with the quality of those who will be representing them abroad and with ensuring that they operate in accordance with the general principles of company policy. It is not surprising, therefore, that the Shell Petroleum Company should have developed one of the most advanced systems of training in this country. This covers every level of technical and staff training. At the present time management training at Shell is a four-tier affair which starts with a course for trainees in London or on-the-job training in overseas countries. Then, for men taking up their first executive jobs, there is an executive development course in London or the Hague. A general executive course is run at the residential staff college at Teddington for men destined for senior management positions and, finally, there is a management study group specifically for those who are potentially top managers. I.C.I. have a staff training centre at Kingston-on-Thames at which executive development courses are given in supplementation of the training schemes of the divisions.

Among the nationalised industries, the Central Electricity Authority runs a number of such courses at its two residential training centres at Horseley Towers, Surrey, and at Buxton. These are attended by 18 managers at a time and last three weeks. The National Coal Board runs longer courses at its staff training college at Chalfont St. Giles, and British Overseas Airways has for some time held courses in hotels. The Royal Ordnance Factories have a residential staff management school at Swynnerton.

A particularly interesting example of what can be done in a small company, described in the report mentioned above, is the staff school of Frederick Smith and Company, Wire Manufacturers, Limited, which was founded in recognition of the need to cope with the continuity of change. It is not only used for all levels of staff training, but also to keep executives abreast of new ideas and their part in them. It is considered as an integral part of company administration and every two years departmental heads are required to re-write the descriptions of their departments used in the school, thus ensuring a periodical review of organisation. Changes in administrative method may only be made through the staff school.

Perhaps the most advanced arrangements for executive development are those established by the General Electric Company in the United States. Functional training has been well established in this company for many years and as many as 120 courses are held in a single

Comfortable, sophisticated surroundings are desirable for the longer residential courses. The National Coal Board have established their staff college in Buckinghamshire.

plant; some of them in advanced engineering techniques. Now all top managers, including vice-presidents in charge of divisions, as well as general and functional managers, are attending, 80 at a time, a three months' advanced management course at a magnificent school established at Croftonville on the banks of the River Hudson. The purpose of this is to develop understanding of company policies and management skills at the top. This company, which has a unitary structure without subsidiary companies, claims that its organisation is highly decentralised so that the maximum responsibility for decisions rests on its divisional managers. It would appear to be a corollary of such decentralisation that steps must be taken to ensure a common outlook among the 1,500 senior managers of the company and this seems to be the main purpose of the school. In the same way the American Telegraph and Telephone Company runs a course of two to four weeks for the 850 departmental heads of its widespread associated companies who are substantially the formulators of policy.

Method studies with detailed consideration of case histories are a feature of many management training courses. The Central Electricity Authority run courses both at their headquarters and at residential staff colleges.

An interesting example of a school established by a company with broad international connections in order to train its managers in the problems facing such companies, is the Centre d'Études Industrielles established at Geneva by Aluminium Limited, of Canada. This school, which is mainly for new entrants to the company, is also open to students from outside the company and has recently become associated with the University of Geneva. Although primarily a post-graduate school, consideration is being given by the company to a proposal that men shall return to the school for short periods after having been in employment for three or four years.

There are two dangers in these internal training methods when used for executive development up to the top management level. The first is that of in-breeding so that the developing manager becomes hide-bound by the policies and procedures of the only organisation within which he has ever worked. It is sometimes claimed by the largest companies that they cover such wide varieties of product and function and have so many subsidiaries or divisions that, by suitable rotation, the manager is given a sufficiently wide experience to prevent narrowness of outlook; but that the problem is recognised is shown by the fact that some companies invite students from outside the company to attend their executive development courses.

The other danger is that, in subjecting everyone to the same type of course, sufficient attention is not being paid to the peculiar requirements of the individual himself. For this reason it is at least necessary to supplement internal courses with extra-company activities based on the ascertained needs of each individual. These can include courses in special subjects, attendance at the Administrative Staff College and similar courses, periods of travel or attendance at, for instance, the Harvard Business School. The idea

is even growing of the "sabbatical year" in which the manager is free, like a university teacher, to undertake any form of inquiry connected with his work that he likes; during this year he has time for leisure to think out what has already been learnt and to formulate his ideas. Something of the sort will become increasingly necessary as the pace of technical and economic change imposes heavier loads of decision on those at the top of large enterprises.

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COLOUR TELEVISION AND BIG BUSINESS

A plea to industry to stop all the "useless" propaganda that goes out about colour television and, for the time, being to regard colour as a laboratory secret was recently made by Mr. C. O. Stanley, chairman and managing director of Pye Limited, Radio Works, Cambridge, Cambridgeshire. It was a recent visit to the United States that prompted Mr. Stanley to express these sentiments.

He remarks "I realised that the problem of 625 lines versus 405 lines was unimportant compared with the economic situation that had arisen in connection with colour television in the United States. Firstly, one observed that the profit margin on ordinary black and white television sets had completely disappeared. Admittedly there were one or two companies like Zenith and Magnavox still making profits, but Philco, Admiral, and Emerson were being talked about as being in 'a very difficult situation.' Undoubtedly the collapse of the market has been due to the development of colour television and by companies with multiple interests deciding to come out of television —firms such as Columbia, Raytheon, etc. Obviously they had to dispose of their stocks, which they did at very low prices, bringing the price of the standard black and white receiver down by 25 to 30 per cent.

While this was going on, R.C.A. was pumping everything it could into propaganda on colour television, and its network outlet, N.B.C., was putting out three hours of colour programmes a day. The result was that intending purchasers, persuaded that colour television was just around the corner, would only buy the very cheapest black and white sets. Very quickly a new low level of about 160 dols. for a black and white receiver was established. It then became clear that in a short time the public would be prepared to pay only about 10 per cent. more for a colour television receiver than for a black and white one. Thus the price they were prepared to pay was under 200 dols. while the market price of a colour receiver was 500 dols. A situation has now arisen in which there is virtually only one manufacturer in the market, R.C.A., which has made 102,000 colour sets in the last year. Three years ago Sarnoff budgeted for an annual production of colour receivers during this period of over six million."

The Sarnoff referred to is presumably David Sarnoff, chairman of R.C.A. The latter firm is at present faced with three anti-trust suits all making similar charges of "monopolistic practices." The latest was brought by the Philco Corporation and is a suit for 150 million dols. against the Radio Corporation of America, General Electric, and the American Telephone and Telegraph Company. The two earlier actions, which were brought by the Zenith Radio Corporation in 1946 and the federal government in 1954, are still pending. Philco hold that R.C.A. has become, in effect, "sole licensor" for the electronics industry, partly through patents it holds directly, and partly through cross licences with other firms. R.C.A. is also accused of using their ownership of the N.B.C. to force Philco to sell a Philadelphia television station at less than value. Philco claim that these manoeuvres have cost them 50 million dols.

All of the charges are denied by R.C.A., who describe the action as an attempt to "throttle development of colour television."

Weekly Survey

Cover Picture: *The profile machine is able to reproduce complex shapes by means of its "feeler." It is shown machining the die for a pipe in a helicopter engine.*

★ ★ ★

British Jets for B.O.A.C.

Following several months of rumours that British airlines were discussing jet airliners of medium and short range with the leading British manufacturers, it was announced last week by the Minister of Transport that Government approval had been given for the expenditure by B.O.A.C. of some £68 million on 35 VC-10 airliners to be built by Vickers-Armstrongs (Aircraft) Limited. This aircraft is at present only in the design stage and it is understood that orders will finally be placed when detailed specifications have been agreed between B.O.A.C. and Vickers. Delivery should begin in 1963.

The major point of interest in this new order is that the VC-10 has been planned for a world market. The long-range jet airliner market has so far been dominated by American manufacturers—so much so that B.O.A.C. have been compelled to order Boeing 707's to maintain their competitive position on the North Atlantic route. The new aircraft is described as being in the medium to long-range class and is destined for use on the Corporation's African, Far Eastern and Australian routes in conjunction with the Britannias and Comet 4's already ordered. Its cruising speed will be competitive with those of other jet aircraft operating in the mid-1960's (around 600 m.p.h.).

With the rapid rise of aircraft design and development costs it is impossible for a manufacturer to recover his costs on orders from British airlines alone. Recognising that the immediate market for long-range aircraft has virtually been lost to the Americans, it is believed that the medium to long-range field offers better prospects for breaking into the world market.

In this connection it is particularly relevant that the VC-10 will be developed entirely at Vickers-Armstrongs expense. The pressure of world competition works in two ways. In the first place no private company can be expected to undertake the enormous costs of developing a new aircraft without being assured at least of some initial orders—which must come from British airlines. In the second place, even if this support is forthcoming, these costs cannot be recovered without the aircraft finding a world market. Consequently, B.O.A.C. specifications, even though designed for routes peculiar to itself, must be drawn up with reference to other airlines' operating conditions. It is believed that the VC-10 specification achieves this. The time is rapidly approaching when economic conditions will not allow a world market for more than two or three aircraft types within any one field. It is therefore only sound economic common sense to recognise the ascendancy of the American manufacturers in the long-range market, in the immediate future.

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Third-Rail Electrification

Orders just announced by the Southern Region of British Railways mark the first major step towards extending the 660/750 volt third-rail electrification from Gillingham and Sevenoaks to the East Kent coast. All the lines in the area shown as scheduled for conversion on the third-rail system in last year's British Transport Commission report on electrification are covered by the equipment now ordered. The 63 substations for which rectifiers and switchgear are to be supplied will serve 250 route-miles—a striking contrast to the 12 substations estimated as necessary for the 495 route-miles of the 25 kV, 50 cycles per second Euston-Birmingham-Manchester-Liverpool scheme.

Work in East Kent will be in two phases, the first from Gillingham to Ramsgate, Canterbury and Dover, including the branch to Sheerness; and the second from Sevenoaks to Tonbridge, Ashford and Dover, with the Paddock Wood-Maidstone-Ashford loop and the lines from Ashford to Ramsgate and Ore, and from Minster to Dover.

Fixed equipment will be similar to that used in the London area change-of-frequency scheme, with pumpless steel tank rectifiers at 32 substations and glass bulbs at the other 31. Substations will be under remote supervisory control from two control rooms, at Canterbury and Paddock Wood. Features which have proved their value in the change-of-frequency scheme, such as miniature key switches to allow the presentation of complicated layouts on mimic diagrams of reasonable size, and provision for simultaneous reclosing of numbers of circuit-breakers to minimise the time required for re-energising a section of line, will again be incorporated. Oil-filled cable for high-voltage distribution to substations, used throughout the London work, has been ordered for the first phase of the East Kent scheme.

It is probable that this scheme will be the last third-rail low-voltage direct-current electrification on such a scale in this country. If it were decided to electrify the Southern Region's West of England main line from Waterloo, it is probable that the high-voltage alternating-current system would be chosen in spite of the fact that the third rail extends as far as Pirbright Junction, between Brookwood and Farnborough. A similar junction between overhead alternating-current and third-rail direct-current electrification occurs on the New York, New Haven and Hartford Railroad where the main line joins the connection to the Grand Central Terminal, New York. The latest alternating-current locomotives have therefore been equipped with rectifiers and direct-current motors, and on the third-rail section collect current through shoes connected to the power circuit at the output side of the rectifiers.

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B.S.A. Out of Cycles

The ruthlessness of competitive selling is being felt to its most unpleasant extent in the cycle industry. A few months ago Tube Investments decided to concentrate the whole of the group's output in one large modern factory. Now Birmingham Small Arms Company are abandoning the manufacture of pedal cycles. As from June 1 the whole of the cycle manufacturing business carried on at Waverley Works, Birmingham, will become the property of Raleigh Industries. But Raleigh will not acquire the works which extends over 30 acres and has a capacity of 8,000 cycles a week; they are concerned only with the goodwill attached to the B.S.A. makes and will manufacture them at their Nottingham works. They announced that the separate identity of the B.S.A. cycles would be retained.

The pedal cycle industry is one of the first engineering industries to alter its structure radically on account of current competitive pressure. The first and best known was probably the steam locomotive industry, which turned over from the building of steam locomotives to that of Diesel and Diesel-electric and became closely associated with the electrical engineering industry in the process. In the case of the cycles also it is the considerable dependence on exports which is the major factor. There has been a marked change in the American consumer's preferences from the light cycle which Britain exports to the medium types sold by Germany. In addition competition from Japan is once again becoming acute. It has been apparent

for some months that only the largest and most modern units would survive, particularly when the Government decided to impose restrictions on hire purchase. The sad demise of the B.S.A. cycles group, which had incurred losses for several years, was thus only a question of time.

There are now only two giants in the industry. Of the two, Raleigh have the edge at present over their rivals Tube Investment, and are likely to keep their advantage until T.I.'s new factory is fully operational. B.S.A. have retained their motored cycles, the New Hudson auto-cycle and the B.S.A. "Winged Wheel," the manufacture of which has been transferred to the motor-cycle works. Perhaps they will be proved right—the future may well belong to the motorised cycle, leaving the pedal cycle a much restricted market.

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American Automobile Unions

Long-term wage agreements about which there has been much discussion lately are already nine years old in the United States. They are the result of a number of factors in the capital and labour set-up of the industry. The American motor industry is dominated by three giant companies—General Motors, Ford and Chrysler. Of these, General Motors has over 400,000 workers—the other two have about 140,000 each. Between them, these three make 95 per cent. of the 5½ million passenger cars and over three-quarters of the 1 million lorries built in the United States each year. By the end of 1954 only three of the smaller car companies were still in business. These are American Motors Corporation, Studebaker-Packard, and the Kaiser Motors Corporation. Not only is the industry limited to a few firms, it is also concentrated geographically. Over half the industry is located in the State of Michigan centred on Detroit. A further 16 per cent. of the industry is in the neighbouring States of Ohio and Indiana. Vehicle parts are made in factories scattered over some 30 States.

The majority of American motor workers are in one big union—the United Automobile, Aircraft and Agricultural Implement Workers of America (U.A.W.). Not only is this Union predominant in the motor car industry, it is the principal union in the agricultural implement industry, and has substantial membership in aircraft and metalworking. In 1954 the U.A.W. had a paid professional and clerical staff of 950 engaged in administration, research publicity, social security, legal matters, political action and other activities. The average monthly cost of operating the Union exceeded 1 million dols. The average Union membership is 1,300,000, of which 1,100,000 are in the motor car section. The Union has 175,000 women members and 400,000 negroes. One in every 15 of U.A.W. members (i.e., 75,000) is an officer, a shop steward or a committee member. In 1948 the U.A.W. negotiated a two-year agreement with General Motors which included the now famous annual improvement factor and escalator clause to adjust wages to changes in the cost of living. This pioneer negotiation was re-affirmed in a five-year contract between General Motors and U.A.W. signed in May, 1950. It is not surprising that the new form of agreement should have started in the biggest firm in the industry. Advance in automation and the previously bad record of labour relations just do not go together. The new style wage agreements are now spreading in ever widening circles throughout the manufacturing industry.

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Oil in 1956

The Statistical Review of the World Oil Industry for 1956 published by the British Petroleum Company, Limited, last week shows to what extent the Suez crisis acted as a check to the growth of Middle East oil production. In contrast to the post-war period up to 1955, when the average annual rate of increase in oil production in the Middle East was 19 per cent., the increase in 1956 fell to 7 per cent. over the previous year. Meanwhile, the Middle East share of world output dropped from 20·2 per cent. in 1955 to 19·9 per cent. in 1956.

Total world production of oil in 1956 rose by 9 per cent. to 857·1 million tons and the United States was again by far the biggest producer with 380·5 million tons, an increase of 6 per cent. over the previous year. The Middle East with 169·9 million tons in 1956 was followed at no great distance by the Caribbean oilfields which between them produced 135·9 million tons last year and showed a 13 per cent. increase over 1955. While production of oil in the western hemisphere continues to rise, however, the potential of the Middle East is still unquestioned. At 19,300 million tons, the "published proved" oil reserves in this region account for 62 per cent. of world reserves and show a 15 per cent. rise over 1955.

Despite the check to her Middle Eastern supplies, Western Europe, helped in part by increased imports from the United States and the Caribbean, increased her oil consumption by 13 per cent. in 1956, the biggest rise shown by any area except the U.S.S.R. To some extent, however, this increase was met by drawing on stocks, since net imports into Western Europe rose by only 10 per cent. during the year. The growth in refinery capacity in Western Europe continued during 1956 and by the end of the year total capacity had reached 127·2 million tons per annum, an increase of 13 per cent. on the previous year.

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Australian Tariff Cuts

The recent improvement in Australia's balance of payments position following a larger income from the wool clip is enabling the Australian Government to make tariff reductions on over 800 items under the new trade agreement with this country. About one-third of Australia's total import bill last year was accounted for by these categories which cover mainly capital goods and raw materials for Australian industry. The general effect of the reductions will be to increase the competitive power of countries other than the United Kingdom in the Australian market. Tariff concessions as large as from 17½ to 7½ per cent. have been made on some goods. In the case of capital equipment there has been a reduction from 12½ to 7½ per cent. for goods required to develop Australian industry. Where such goods are not available from Britain they will be admitted duty free from other countries.

The new day, promised in the recent trade treaty between this country and Australia, has thus dawned somewhat bleakly for those exporters in Britain who have long enjoyed substantial imperial preferences. It is apparent that Australia intends to buy cheaply and from a much larger variety of suppliers than in the past. Increasing competition in the Australian market is now a fact for the British exporter. There are other straws in the wind besides the tariff reductions. Groups of Australian buyers have been seen with contracts in their pockets as far north as Stockholm and the hotels of northern Europe are opening their doors to a growing clientele of visiting Australian businessmen. Equally, western European concerns which have never done business beyond the Indian Ocean are now seeking active representation in Australasia. The systematic exploitation of that market by the Germans has been increasingly apparent in consumer and capital goods for a year or two and other countries on the Continent are now following their example. The British exporter is under notice to sell in that market as he has never sold before.

Standardisation and the Free Trade Area

The meeting of the Industrial Truck Section of the Federation of European Manufacturers at the end of last month was mainly concerned with questions of standardisation. The importance of this subject for many engineering concerns when the Free Trade Area is in sight needs no emphasis. It is obviously of the utmost importance to achieve a measure of standardisation so that the European market can be adequately exploited, but it is also important to decide where that standardisation should stop.

The fork lift truck manufacturers represented at the conference in Italy agreed that further tests should be made before the next meeting in Vienna in October, 1957, to find a general formula to cover calculated static and dynamic conditions both in longitudinal and lateral planes of conventional tilting fork lift trucks, whether on solid, cushion or pneumatic tyres. The French delegation asked for a common code of usage on public highways. In France at the present time industrial trucks are in the same category as mobile cranes so far as Government regulations are concerned, as decreed by the Ministry of Public Transport two years ago. This is in complete contrast to the United States where there is no restriction on the use of industrial trucks on public highways. The Belgian and the Swiss pressed for standardised tyres on the basis of size indicated by the American Tire and Rim Association. Other proposals on this subject came from Germany, France and Sweden. The British delegation said that American sizes were not recognised in the United Kingdom but would investigate the possibility of producing tyres according to American specifications. It was agreed, however, that there should be some basis of standardisation for tyres and rims. The standardisation of controls for self-propelled industrial trucks and standard voltages for electrically powered types were also considered and further reports on the subject are to be submitted at the Vienna Conference.

It is apparent that most industries have a major task ahead in developing a code throughout Western Europe of common usage for their equipment. The history of engineering development is strewn with examples of markets closed to products of proven efficiency and competitive price which have fallen foul of local prejudices, safety regulations and lack of standardisation in the equipment itself or in the products for which it is a component. Much useful preliminary work might be done in these Aegean stables before the Free Trade Area becomes more of a reality. The rapid expansion of the European engineering market will owe much to detailed work of this kind and the sooner it is put in hand the better.

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Common Sense on China

At long last the deadlock on the embargo on trade with China would appear to be broken. There is now little doubt that the control of exports to the Chinese mainland will be brought into line with the schedule which regulates trade with the Soviet Union. For too long now the intransigence of the United States Administration has been allowed to prevail over everything else. There was certainly little sense, as the British Government pointed out at Bermuda, and later at the recent conference of the China Trade Committee in Paris, in allowing a wide range of capital goods into Russia which could be re-exported to China without any difficulty whatever.

Already the "exceptions procedure" to the embargo operated by NATO made possible the export of engineering products such as tractors, road vehicles, certain types of machine tools, some steel and other goods—each specific shipment being granted permission by the Board of

Trade. But the existence of the total embargo made trade relationships with China difficult and there is little doubt that trade will increase as soon as the embargo is lifted. Manufacturers will be able to sell these—probably in person if they so wish—without constant doubts concerning the granting of export licences. China is said to be keenly interested in obtaining supplies from Britain, and to have built up substantial sterling reserves.

British representatives in Paris made it quite clear, as Mr. Allan Noble, Minister of State for Foreign Affairs, said in the House of Commons, that " if there is no agreement reached we shall have to reconsider the whole position." The only solution is for a general review of the embargo list, retaining only a sensible and logical selection of genuinely strategic goods. If this is done soon, the Chinese market may yet become one of the major outlets for British engineering products. This applies particularly to tractors and agricultural machinery, as the Agricultural Engineers Association have never tired to drive home.

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Building—Higher and Higher

There is no sign of any decline in building and civil engineering output. In the first quarter of this year the amount of work done was 6 per cent. higher than in the same period of 1956 and the highest ever achieved during the winter months. The value of all work done, at £525 million was over 11 per cent. more than a year ago. A major contributor to this excellent performance is undoubtedly the dry and unseasonably warm weather in the early months of this year.

The rate of house building is tapering off but the industry's activities in other fields are increasing. Labour employed in these sectors was 6 per cent. higher at May 1 this year than a year ago and the rate of output of industrial buildings is understood to be still increasing. It is difficult to say how long this trend will be maintained. The Board of Trade's latest forecast —based on returns of future capital expenditure by 600 firms—indicate that spending on industrial building will be 9 per cent. lower this year than last. Should this in fact take place there might be serious unemployment in building and civil engineering, since housing output can be expected to decline still further. But there are a number of factors difficult to assess at present. First it is always possible for the rate of capital investment to increase (or decrease) suddenly—if the Budget has been well received, or if industrialists find themselves better placed to sustain expansions.

The signs now are that there might well be an improvement on the Board of Trade's forecasts. In addition there are slum clearance schemes, road construction and various possible major schemes could quickly take up any slack that may develop. Meanwhile less congested programmes should lead to quicker progress and probably to even higher output during the spring and summer.

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Overseas Civil Engineering

While the activity of building and civil engineering contractors in this country has continued at a record level over the past year there has been no further increase in output since the second quarter of 1956. If new housing work is excluded the total output of building and civil engineering contractors has been running at a little over £1,500 million per annum. In view of this particular interest attaches to the progres of British civil engineering contractors overseas.

In this field two important contracts have recently been won by British companies. Richard Costain have been awarded a £3,650,000 contract by the Barbados Government for the construction of a deep-water harbour at Bridgetown. This includes the construction of roads, warehouses and a stacking area on 85 acres of reclaimed land. In addition, berthing facilities will be provided for larger vessels which now have to off-load their cargo into lighters. In North Iraq, Balfour Beatty and Company, Limited, have secured a contract valued at £1·2 million for the laying of transmission lines, which follows a contract valued at £1 million and secured by the same company to build a regulator on the Euphrates.

Figures have not yet been published for the total value of overseas contracts secured by British civil engineering companies in the year ending March, 1957. It is, however, expected that the total will be at least equal to the figure of £109 million for the previous year. It also seems probable that the Commonwealth will account for some two-thirds of the new contracts received as has been the case during the last few years.

Africa continues to be the largest overseas market for British civil engineering contractors, followed by the Near and Middle East. In the last two markets, British companies appear to have been successful in meeting cut-throat competition from European competitors, of whom it is reported a number have now ceased operation. Several British contractors have, however, recently complained of the favourable credit facilities available to foreign competitors, particularly the United States, German and Russian companies. This is not normally a serious problem in the Commonwealth, but it may well be one of the main factors preventing further expansion elsewhere.

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The Academics of Television

There have been discussions in the North of England to establish a chair or lectureship in television at one of the northern universities. Granada Television Network have let it be known that they intend to foster the academic study of television " as a medium of communication in fields of information, entertainment and the arts." They also have in mind to establish an annual research scholarship and sponsor a series of lectures. The annual scholarship will be available to graduates to enable them to present a thesis on aspects of television and the lectures will be given by people who have made a technical or sociological study of the subject or who have " a contribution to make to the creative and artistic development of television." The phraseology of this last remark suggests the advertising rather than the academic world. It is assumed in all this that television is something more than a medium for persuasion, education or entertainment and that it possesses merits which should be actively fostered.

The technical side of television is already covered by electrical engineering and electronics. Any academic work would therefore have to concentrate on the presentation of programmes and their impact on the public. There will always be powerful vested interests which will want favourable conclusions reached on this side of television work. But it is a little difficult to see what academic study could do in this field which is more likely to be the happy hunting ground for consumer surveys. The justification for academic recognition of television in its own right presupposes that it involves a definable body of knowledge on a subject which can be isolated sufficiently to create an intellectural discipline. If it does not meet these criteria it is at best an offshoot of some other discipline. From an academic point of view it is difficult to visualise what is left of television when physics and sociology have taken their reasonable share of the field. He will be a courageous and imaginative incumbent of an academic chair who can find truth at the bottom of the well which is littered with advertisements for pharmaceuticals and with theatrical showmanship.

There is undoubtedly a major task confronting society in the next generation or two in assessing the impact of the television screen on the public's consciousness. Much survey work will have to be done to discover not only the conscious reactions to advertisements and programmes but even more should be done to assess the less direct impact which this medium of mass entertainment, education and salesmanship has on a somewhat gullible public. It remains an open question whether a seat of learning is the best headquarters for such activities.

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Bearing the Man in Mind

There is a story well known to an older generation, concerning some men who made money very rapidly by making a corner in the match industry. The book was called *Rodin's Corner*, written by Seton Merriman. There was only one trouble about the process and that was that so many poisonous fumes were given off that all the workers died after a very short time—not really an economical proposition from the recruiting point of view.

These things still occur in spite of all the efforts that are being put forward by various factory welfare organisations, but fortunately, unlike the Rodin concern, they do not often get into the factory field. No man likes the feeling that he is compelled to work at the speed laid down by a machine. Even though he may be well capable of maintaining that speed, the very fact of being required to maintain it will affect him adversely, usually with the result that he tends to slow down, the machine overtakes him, he becomes worried, and the work suffers.

An example of a machine where this point has been considered is the electronic sorter now being introduced by the Post Office and described in an article elsewhere in this issue. Although this machine is capable of working much faster than the man, it does not drive him on and he feels that he can go at his own speed. Incidentally, this point is rather necessary, as before he operates the controls to divert a letter to its appropriate pigeon hole, he has to decipher the address, an operation which may take a very variable time.

It is not a simple matter to arrange for the comfort of the worker, not when a real investigation is made. Even a difference of an inch in the height of a chair can change a fatiguing operation into one that can be managed comfortably so that the worker does not feel exhausted at the end of the day. It is these little things that count, that make all the difference between a contented workman and one who feels vaguely dissatisfied and consequently does not give of his best.

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High-Head Profits

The major units in the pump manufacturing industry report fair to good results during 1956. Their interpretation of prospects varies somewhat but none shows any pessimism. Order books are well filled and companies are gradually reaping the benefits of heavy capital investment and expansion during the past few years.

The most successful was Worthington-Simpson, whose output of pumps is not much less than the largest company's in the industry, G. and J. Weir, Limited. Worthington-Simpson lost their managing director, Mr. John Southern, who had held the post for 24 years. His death last December came at the peak of his company's fortunes. Profits on trading amounted to £1·1 million, nearly one-fifth greater than in 1955. Their chairman, Sir Samuel R. Beale, commented that the order book stood " at its customary high level " and that the volume of incoming business had been maintained in the first quarter of this year. G. and J. Weir, whose profits at £3·3 million were only slightly less than last year, purchased William Simons and

Company, Limited, during 1956 to secure suitable factory space for expansion. Their chairman, the Hon. J. Kenneth Weir, said that the purchase of Simons was made necessary because the size of some of the company's products is tending to increase, for example, the ancillary plant of modern turbo-alternators such as feed-heaters, de-aerators and boiler feed pumps. The capacity of G. and J. Weir's works and also those of Drysdale and Company and Zwicky Limited, increased substantially during the year. The group are actively engaged in the development and manufacture of pumps for nuclear energy applications.

The Pulsometer Engineering Company, Limited, and the Harland Engineering Company, Limited, approximately maintained their position. Pulsometer have continued to expand and are continuing to do so—partly through the acquisition of companies such as Joseph Evans (Wolverhampton), Limited, and Skyki Limited, partly by increasing the size of existing works. Their chairman, Mr. F. B. Duncan, stressed his confidence in the future and his belief that "the demand for your company's products will be limited only by the amount and efficiency of your production." Mr. A. H. Cowan-Douglas, chairman of Harlands, commented that orders booked for their main Alloa works totalled over £2 million, and that the order book of some £3 million would keep the company fully employed well into 1958. There would appear to be little cause for worry in the pump industry.

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Moulding the Pattern of Industry

The annual reports of companies such as Unilever, British Petroleum, E. I. Du Pont de Nemours and Monsanto Chemicals, make useful reading for the engineering business forecaster. They provide a very good indication of the intentions of big business during the coming few years.

The giant among giants, Unilever, had an income of £1,671 million last year, over £150 million greater than in 1955. None of the others compares in size with Unilever. British Petroleum's income of £722 million comes second, followed by that of Du Pont at £680 million (1,917 million dols.), then Imperial Chemical Industries at £416 million and, a long way behind, that of Monsanto Chemicals with £14 million. If one or two of the leading motor vehicle companies, such as General Motors Corporation and the Ford Group, and the other big oil companies are included, the picture of the large buyers of engineering products is fairly complete. The continuous and rapid growth of these companies, with vast research and development divisions where machinery and plant is developed and adapted, is of the greatest significance to the engineering industry. Increasingly these companies are giving a lead in design and in the adoption of standards. Together with the large public undertakings in this country and elsewhere, and the purchasing missions of overseas countries (the Communist States are not alone in this) these large companies are creating a section of using industry which—by virtue of the assistance, such as technical help and development contracts—will in time alter the shape of the engineering industry itself. Large buyers call for large suppliers, and the process is already well under way.

Unilever's directors give details of the Group's capital expenditure, which will include £37 million of new projects approved during 1956, compared with £41 million the previous year (due to large expenditure on ships). Du Pont's statement gives much information on research, including a study commissioned by the United States Atomic Energy Authority "to determine the feasibility and economics of heavy-water-moderated reactors for electric power generation." Last year B.P. spent £86 million on capital account; this year they have planned to spend £120 million. The average capital employed by Monsanto, which rose from just over £5 million in 1949 to just below £15 million in 1956, gives some indication of the company's rate of growth. The picture presented by Sir Miles Thomas in his first report as chairman suggests that Monsanto will fill at least some of the gap during the next few years between themselves and the others mentioned in this note.

Letters to the Editor

TRAINING IN THE USE OF INFORMATION

SIR, Your Plain Words comment, in ENGINEERING for May 17, on industry's ignorance of the facilities offered by research organisations, illustrates yet again one of the main deficiencies of present-day technical education, both in the technical colleges and in the universities; namely, their failure to insist that all students receive, in addition to their actual engineering instruction, a course, with practical exercises, on the scope and use of sources of information (books, periodicals, abstracts, indexes, research organisations, libraries, and so forth).

This matter is not likely to be taken seriously in any but the most enlightened colleges, until the syllabuses of the engineering institutions and of the colleges themselves are widened to make such knowledge compulsory.

Yours faithfully,
E. G. BAXTER,
Librarian.

Technical College,
Coventry.
May 20, 1957.

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NOTATION IN STRESS ANALYSIS

SIR, As one who is at present closely concerned in the preparation of a further part of B.S.1991, which will cover "materials" and "structures," I welcome Mr. John Case's letter (ENGINEERING, May 17, page 616) suggesting qualifications to some of the preferred symbols of that specification, and, in particular, his advocacy of σ for stress and ν for Poisson's ratio. The first preferences in B.S.1991 are now: f or q for stress, and σ for Poisson's ratio; an obvious hangover from engineering practice of 50 years ago, but a symbolism which has very largely lapsed following the publication of Timoshenko's authoritative series of text-books.

At the recent conference at the Institution of Mechanical Engineers on "Materials at High Rates of Strain," every speaker who used the blackboard or showed a slide—whatever his country of origin or present nationality—automatically adopted σ for stress, and, by implication, would have used ν for Poisson's ratio.

Nevertheless, the precedent of Part I must inhibit, if it does not literally bind, the authors of subsequent Parts of B.S.1991, in default of an overriding weight of competent opinion which it is hoped your correspondents will be stimulated by Mr. Case's letter to express.

Yours faithfully,
E. H. BATEMAN.

Sandyridge,
Upper Bourne,
Farnham,
Surrey.
May 23, 1957.

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SIR, I agree with Mr. John Case, that it is high time to standardise symbols used in "strength of materials" and the "theory of structures." However, apart from the usual difficulty of the shortage of alphabets, there is the great difficulty of providing students, who are taking various groups of subjects, with symbols that are adequate and yet not too repetitive: the choice of symbols should be such, that in any one subject pursued to graduate or post-graduate level, there should be a continuity of significance for each one. For example, in dealing with beams, external moments and internal bending moments should be distinguished at an early stage, otherwise confusion arises in dealing with, say, the method of moment distribution. If C is used for external couple or moment, taking clockwise as positive, and M only for bending moment, confusion disappears. Another point in connection with beams is the symbolism for co-ordinates. If u and v are used for co-ordinates from the principal axes, one of which is the neutral axis for bending, and x and y for co-ordinates from any other pair of axes, the student will start with u and v, since asymmetrical bending is not encountered at an early stage. Later, when he may be dealing with elasto-plastic conditions, or with hooks, etc., the distinction between the neutral axis and an axis through the centroid may be made by utilising suffices.

With regard to stresses in general, I would prefer to use different symbols, say f, p, q for tension, compression and shear, and also to use e and γ for direct and shear strain. Fatigue failures suggest an inherent difference between tensile and compression loading which may be more conveniently represented in an equation if different symbols are used. One last point is that I prefer to use ρ for curvature, since, in dealing with slightly curved beams, it is the change in curvature which is equal to $\frac{M}{EI}$ and, of course, in graphical work, it is usual to plot the curvature diagram as a preliminary to finding the deflected shape. The basic bending equation then becomes

$$e = v\rho \text{ instead of } \frac{f}{E} = \frac{y}{R}$$

for a material obeying Hooke's law.

Incidentally, B.S.449 "Use of *Structural* Steel in Building" and several others, such as, for example, B.S.2573 on "Report on Permissible Stresses in Crane Structures," which is later than B.S.1991 (Part I) 1954, will need amending if the British Standards Institution's policy is to be consistent.

Yours faithfully,
R. G. FUTCHER.

Loughborough College of Technology,
Loughborough,
Leicestershire.
May 23, 1957.

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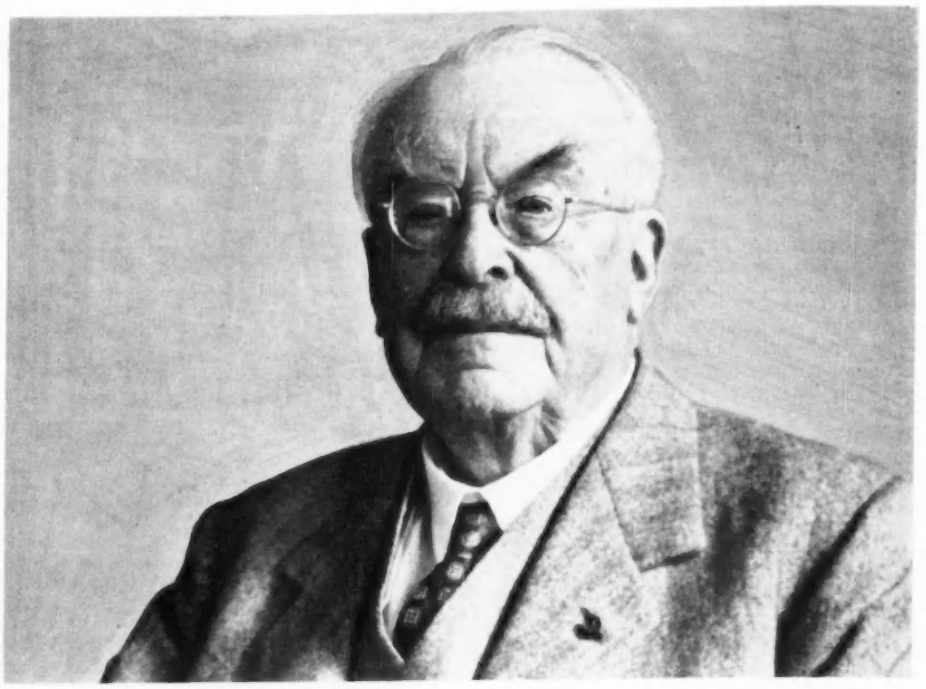
POWDER METALLURGY ORGANISATION

It is announced that the Councils of the Iron and Steel Institute and the Institute of Metals have formed a Powder Metallurgy Joint Group, the objects of which will be to study the science, technology and practice of powder metallurgy. Membership of the new group will be restricted to members of the two Institutes, but meetings of the group, as of the two parent bodies, will be open to non-members.

The inaugural meeting will be held at Church House, Great Smith-street, London, S.W.1, on December 4. There will also be an all-day discussion on "Developments in the Practice of Compacting and Sintering" in March, 1958, and an all-day discussion on "The Powder Metallurgy of Ceramic-Metal Materials" in the autumn of next year. The activities of the group will be administered by a Powder Metallurgy Joint Committee, of which Lieut.-Colonel S. C. Guillan, secretary of the Institute of Metals, 17 Belgrave-square, London, S.W.1, will be the secretary.

Obituary

SIR ALFRED HERBERT



It is with much regret at the loss of a most colourful personality as well as an outstanding engineering industrialist that we record the death, on May 26, of Sir Alfred Herbert, K.B.E., founder of the machine-tool firm which bears his name. In the branch of engineering with which he was most closely associated, he had been a prominent figure for more than half a century, but his name was familiar also to a much wider public as a commentator on current political and economic trends who, in his speeches and published writings, sought by every means in his power to drive home, as he saw them, the basic principles of industrial progress and national wellbeing in plain and pungent terms to be "understanded of the people."

Alfred Herbert was born on September 5, 1866, so he was in the 91st year of his full and vigorous life. He was the son of William Herbert, of Leicester, and was educated at Stoneygate School in that town. His engineering training was received with Joseph Jessop and Sons, also of Leicester, a firm of general engineers whose principal business was the construction of cranes, with whom he served an apprenticeship from 1881 to the end of 1886. Sir Alfred has recorded that his father had intended him for the Church, but one day the youth visited the Jessop works and there saw an old schoolfellow, William Hubbard, operating a lathe. The sight of the chips coming cleanly away from the point of the tool so fascinated him that he decided forthwith to be an engineer; an ambition to which, fortunately, his father deferred. On the conclusion of his apprenticeship, he obtained a post as manager of the small and old-fashioned works of Coles and Mathews, of Coventry, at a starting wage of £2 per week. Shortly afterwards he and his friend Hubbard bought the business with capital provided by their respective fathers and continued it as Herbert and Hubbard. They equipped it with more modern tools and started to make small machines for the cycle trade, then developing in the Midlands. Some years later, Hubbard decided to return to Jessop and Sons, whereupon Herbert acquired his partner's share and from 1894 onwards traded under his own name. The business grew rapidly under his forceful direction, especially after his development of the Herbert No. 4 capstan lathe and his appointment as British agent for the cycle tubing made in France by the Compagnie Française des Métaux. This was his first venture as an importer, a "side line" (as he described it) which developed greatly when he began to import machine tools from the United States to supplement his own standard manufactures.

Shortly before the 1914 war broke out, the Machine Tool Trades Association was formed and Herbert was a prominent member of it; after the war, he became its President and served in that office for 15 years, from 1919 to 1934. Possibly as a result of his activity on behalf of the Association, he was invited in April, 1915, to go to the War Office as head of a new department to take charge of machine-tool production. He did so, and later, when the Ministry of Munitions was set up, transferred to that Ministry as Controller of Machine Tools. It was for his work in the Ministry of Munitions that he received the K.B.E. in 1917. He was also Officier de la Légion d'Honneur, and the recipient of the Order of St. Stanislas of Russia and the Order of Leopold of Belgium.

At the outbreak of the second World War, Sir Alfred was already in his seventies, but he was still actively conducting the affairs of his firm, of which he was chairman and governing director, and as actively expressing his views on current events and progress and the impact of Government control on industry, both in the Press and in the pages of his firm's house journal, *The Machine-Tool Review*. A selection of his speeches and writings was published in book form after the War; it was reviewed in ENGINEERING of July 30, 1948. Some of the topics are obviously "dated," but our concluding remark, that much of what he wrote and said is "likely to continue worthy of study while the need for such plain speaking persists," is still applicable.

Sir Alfred was a generous benefactor to Coventry and is commemorated there not only by the business that he built up, but by the art gallery and museum, to the establishment of which he contributed £200,000. He was made an Honorary Freeman in 1933. In 1956, on the occasion of his 90th birthday, he was presented with a portrait bust in bronze, the work of Mr. William Bloye, F.R.B.S., by the directors of Alfred Herbert, Limited, and of the associated companies in France, Italy, Australia and India; and, on the same occasion, the Machine Tool Trades Association founded and endowed a travelling scholarship in his name, for the benefit of students of Coventry Technical College. He had been a Member of the Institution of Mechanical Engineers since 1892 and was made an Honorary Member in 1941. He might be regarded also as one of the prime instigators of the Institution of Production Engineers, of which he was President from 1927 to 1929, and which honoured him in 1952 by establishing the Sir Alfred Herbert Paper, the first of which, "The Development of Engineering Metrology," was delivered by Dr. F. H. Rolt, C.B.E.

PLANT ENGINEERS AND AUTOMATION

The theme of the 10th annual conference of the Incorporated Plant Engineers, held at Buxton from May 15 to 17, was "The Plant Engineer's Adaptability to Change," a topic which allowed ample scope, as the ensuing proceedings soon showed. Mr. Vincent Taylor, M.Inst.F., who was installed as the Plant Engineers' president at the opening of the conference, pointed out that automation, which was regarded by some people as the answer to every problem, was a technological answer only, and that engineers' minds must be re-equipped on the same scale as the factories, for out-moded concepts can and will impede progress just as much as out-moded machines.

This idea of mental adaptability was developed further by Sir Oliver Lyle, O.B.E., F.Inst.F., in his paper "The Plant Engineer's Orbit," who suggested that many of the problems confronting a plant engineer could be simplified if he made a habit of looking outside this own particular orbit. Sir Oliver spoke of the plant engineer's relationship with other individuals and bodies, and added a powerful plea for simplicity in the use of the written word. As he said, ". . . too many engineers and technicians write the most appalling stuff," when it is really so easy to write in a straightforward way. A simple, clear report or recommendation can make all the difference to an engineer's efforts to get a job done, and, Sir Oliver said, it might easily help him to obtain promotion.

Automation was mentioned at the opening of the conference, and the concluding paper, by Mr. J. F. Coales, O.B.E., M.A., M.I.E.E., dealt with "The Impact of Automation on the Plant Engineer." The automatic factory was already a technical possibility, though it was a long way from being economically justified at present, said Mr. Coales. Nevertheless, it was on the way, and many components of the automatic factory were already in use. It was considered economic, for example, for a factory employing 200 or more people to use a computer. A time could be foreseen when the plant engineer would be the most important person in a factory, for if the production was to become entirely dependent upon machinery, the economic operation of that machinery would depend upon the organisation set up by the plant engineer. In the discussion on Mr. Coales's paper the suggestion was made that the time might well come when the functions of plant engineer and production manager would have to be combined in a single person, for the development of automatic processes was tending to make a distinction between the functions impossible. The last man to become redundant would be the plant engineer, but, as Mr. Coales pointed out, however perfectly the plant functions, it is no use at all if the product cannot be sold, so another individual, the sales manager, must come into the picture very prominently.

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The general headquarters of the Institution of Electronics is now situated at 78 Shaw-road, Rochdale, Lancashire. The former general headquarters, at 20 Buckingham-street, London, W.C.2, has been made the headquarters of the Institution's London Division. Mr. W. Birtwistle, who has been appointed honorary general secretary of the Institution, will also continue to act as honorary secretary of the Northern Division for the time being.

ENGINEERING FIRMS IN THE FREE TRADE AREA

2—THE CHALLENGE OF MANNESMANN

Steel tubes are an interesting example of one of the phenomena which may accompany the introduction of the Free Trade Area in Western Europe. The internal demand for steel tubes in Europe is likely to go on increasing just as it is in Europe's export markets. In consequence the situation provides an example of the impact of the Free Trade Area on a growing market. For many years the domestic market in Western Europe has been protected for the big steel-tube producing companies by tariffs, quotas and at times by agreements among the companies themselves. Competition has been fierce in export markets and the big concerns have adopted different methods of arranging their export sales. The probability of the European Common Market and the possiblity of the Free Trade Area bring new elements into the calculations of those responsible for working out market strategy.

In this country Stewarts and Lloyds Limited and Tube Investments Limited share the production of welded and seamless steel tubes. The products of these two concerns have for long been complementary rather than competitive, and of recent years Stewarts and Lloyds rather than Tube Investments have been thought of as the United Kingdom's main contender in the export market owing to their major interest in oil industry equipment. Of recent years the two chief contestants from Europe in the world market, especially as suppliers to the oil industry, have been Mannesmann and Stewarts and Lloyds. For these two companies the Free Trade Area means mutual exposure of their domestic markets which have been until now a vital and remunerative preserve for both.

Mannesmann is not the only Continental European tube manufacturer of significance by any means. There are a number of important powerful groups but Mannesmann, both from its outstanding position over 67 years and its notable recovery since the last war, represents a major challenge from the Continent. Other important groups may be mentioned, however. In Belgium, the Usines à Tubes de la Meuse S.A. had a capacity of 250,000 tons a year in 1954, and is connected in the export market (where France and Belgium sell their tube products jointly under the direction of the Comptoir Franco-Belge des Tubes) with Lorraine-Escaut and Vallouec which had between them a capacity of about 800,000 tons a year at that date. In Italy the largest concern is Dalmine, which was taken over from Mannesmann during the first world war. Dalmine's capacity was about 600,000 tons a year in 1954. The rest of the Italian tube industry consists of three much smaller units. In Germany the main producers are the Rheinische Röhrenwerke which made some 800,000 tons of welded and seamless tubes in 1954. The other large group is Mannesmann A.G. with a capacity at that time of about 550,000 tons of steel tubes a year. There are two medium-sized groups in Germany making tubes with a joint capacity in 1954 of about 250,000 tons a year and a few smaller units with a total capacity of about 150,000 tons a year. Taking the Continental European industry as a whole, however, there is little doubt that Mannesmann offers a major challenge both in the quality of its management and the long tradition of powerful competition in world markets upon which it can draw.

GROWTH AND RECOVERY

Mannesmannröhren-Werke was founded in 1890 by Max and Reinhard Mannesmann, the inventors of the skew rolling and pilger processes. Deutsche Mannesmannröhren-Werke, now within the Mannesmann group, was formed in 1952 with plants at Düsseldorf-Rath, Remscheid and Witten. By tradition Mannesmann is a seamless tube concern, but since 1952 the company has manufactured welded tubes as well. Table I gives some idea of the recovery of the German steel tube industry since the war.

Thus despite the intervening war years and the dismantling of German industry after 1945, German tube output increased by 50 per cent. between 1938 and 1955.

The volume of output of Mannesmann's rolled steel products including plates and sheets, increased from just over 500,000 tons in 1951 to just over 800,000 tons in 1955. The value of the output from the tube mills increased over the same period from just over D.M. 300 million to D.M. 700 million. No tonnage figures are published for production of tubes by the company, but output was probably of the order of 600,000 tons of seamless and 100,000 tons of welded tubes. The group has thus substantially increased output both by the rolling mills and by the tube mills. It will be noticed in passing that Mannesmann as a group has a much wider range of end products than Stewarts and Lloyds.

Before considering the market side of the Western European steel tube industry, it is of interest to compare such information as is available about the strength of this German group compared with its principal British competitor. The steel tube industry has for long been noted for its secrecy about figures which might give any worthwhile indication of the competitive strength of different units. Information has therefore had to be assembled from different sources and some of it is approximate. Nevertheless, the data is sufficiently accurate to give an overall impression.

MATCHED COMPETITORS

Stewarts and Lloyds consider that their costs compare favourably with their Continental competitors. Such crude figures as are available bear this out. In 1955, for example, the Mannesmann group produced about 1,786,000 tons of ingot steel and corresponding finished products from units employing about 56,000 workers. The production of ingot steel and processing to finished steel thus works out at about 31 tons per operative. Stewarts and Lloyds in the same year produced about 1,400,000 tons of ingot steel, and with a total pay roll of 26,000 operatives they achieved a throughput of 54 tons per worker. The British company might be expected to have an advantage since they came out of the war with less damage and dislocation than the German concern, have since modernised their plant to a very considerable degree, and are concentrating entirely on tubes. Nevertheless there would seem to be a significant and gratifying difference even allowing for the approximation of the figures and differences in the type of output (e.g. the average diameter of tube has to be ignored). In 1955 Stewarts and Lloyds produced 860,000 tons of finished tubes and Mannesmann, who take some trouble to conceal their production figures in terms of volume, probably produced about 700,000 tons. It is apparent from this that the concentration of Stewarts and Lloyds' resources on tubes gives them a comparatively bigger tube output over which to spread their overhead costs, although Mannesmann have the advantage on ingot steel output.

So far as exports are concerned it would also appear that the British company has the edge on the German group, or at least had up to 1955. In 1955 Stewarts and Lloyds exported 42 per cent. of their tube output. There is a strong presumption (absolute figures are not available) that Mannesmann exported somewhere between 30 and 35 per cent. of their tube output in that year, suggesting that both relatively and absolutely its export sales were smaller than those of Stewarts and Lloyds.

It has to be remembered, however, that the German group was recovering from the war and was in fact travelling at a tremendous pace. To say that the British company was in the stronger position about 2 years ago is to say no more than it had been able to hang on to some of the advantages over the German steel industry which it had built up between 1939 and 1948 when the Deutschmark was finally stabilised. This does not mean that the management of Stewarts and Lloyds may have been less enterprising than that of Mannesmann but it does emphasise that the Germans, although in an inferior position were also in an exceedingly threatening one so far as their competitors abroad were concerned. They had made a remarkable recovery and were more than maintaining the momentum of the expansion of the previous four years.

GROUP EXPANSION

Since the end of 1955 the Germans have made further progress. In March, 1956, Grossröhrwerk Mannesmann-Hoesch G.m.b.H., Duisburg, began producing welded tubes. About the same time Mannesmann joined with Hoesch (taking 60 per cent. of the capital) in a new tube mill at Huckingen with a capacity of 120,000 tons a year. The group also acquired Essener Apparatebau G.m.b.H. of Essen last year, which makes equipment from steel. The company had already begun to diversify its activities by acquiring two motor-vehicle component manufacturers. In April of this year an announcement was made that the group will increase its ingot steel capacity to 2·4 million tons a year while Stewarts and Lloyds will be nearer 1·5 million than 2·0 million tons. If the same proportion of Mannesmann's ingot steel output is used for steel tubes as in 1955, the group's tube capacity will be about 900,000 tons and, of course, the figure may well reach 1 million tons. This may be compared with 981,000 tons produced by Stewarts and Lloyds in 1956. Since nothing is known of major installations at Stewarts and Lloyds due in the next year or two (although there is a 10 year programme to cost £6·25 million which will mainly be used to modernise the coke ovens) there is every indication that Mannesmann will further close the gap in steel tube output between the two companies, although they may not draw level.

In this connection it is of interest to compare the rate of increase in the capital assets of the two companies over the last few years. Taking 1955 as a starting point, Stewarts and Lloyds' issued capital and free reserves amounted to about £45 million. The corresponding figure for Mannesmann was D.M. 450 million or about £40 million. At the same time the fixed assets of Stewarts and Lloyds were worth about £40

TABLE I PRODUCTION OF STEEL TUBES (1,000 TONS)

	Western Germany	European Coal and Steel Community	United Kingdom	Western Europe	United States	Soviet Bloc	World
1938	958	1,450	676	2,226	2,340	962	5,959
1954	1,281	2,525	1,126	3,883	7,859	3,748	16,511
1955	1,435	2,939*	1,283	4,466*	8,896*	4,075*	18,619*

* Estimated on the basis of monthly figures available.

million while those of Mannesmann (taking the figures from the unconsolidated balance sheet to exclude the overseas subsidiaries) were about £42 million. Over the last three years the British company has increased the value of its fixed assets at the rate of between £2 and £3 million a year. In 1955 Mannesmann increased its plant under construction by about £7 million. Earlier figures are not available.

SPECIALISED OR DIVERSIFIED

The general picture which emerges is of an efficient British company remaining highly specialised on a limited group of products and being gradually overtaken by a German concern with a fairly similar capital structure but a larger ingot steel capacity and a much greater diversification of products. In other words, the capital employed per ton of steel ingot capacity in Mannesmann is smaller than in the United Kingdom company. Since the Mannesmann labour force is more than double that of Stewarts and Lloyds, the capital employed per worker is also very much lower. On this analysis, if the theorists about the Free Trade Area are right, the British firm starts in a stronger position than its German competitor.

So far as technical matters are concerned there is little to choose between the two companies on seamless tubes. Both have installed pilger mills which are now most widely used in seamless steel tube making. Mannesmann have always been closely connected with the development of pilger techniques and their name is associated with it. But developments have been made generally available in much the same way as other steel mill techniques have achieved a world market. In welded tubes, Stewarts and Lloyds have a big initial advantage with their Corby works, almost exclusively given over to completely integrated welded-tube production and the development, in particular, of the ERW process. There is no doubt that in the welded tube market (where expansion at the expense of seamless tubes in certain uses has been masked by a shortage of both types) the British company is exceedingly strongly placed.

Whatever may be their comparative advantages, both concerns will face the Free Trade Area with a prospective expanding long-term demand for steel tubes and a run of prosperous years behind them. If it should prove true, as the foregoing estimates suggest, that the British tube industry is favourably placed for attacking the German market will they try to enter each other's domestic market? They are both well-placed for competing in other parts of the Free Trade Area. Mannesmann, of course, may have a trial run, if it wants to have one, in the European Common Market, although the Free Trade Area could come into existence at the same time as the E.C.M.

OVERSEAS POLICIES

In the past, these two companies' "overseas policies" have been quite different. On the whole, Stewarts and Lloyds have preferred to produce in the United Kingdom and to have only selling organisations abroad, although the company now has tube mill interests in Australia and India. Mannesmann, on the other hand, has gone all out in recent years to establish mills wherever the local market justified the investment. In consequence, they have works established in Turkey, Brazil, Argentina and Canada and a minority holding in Société des Usines à Tubes de la Sarre; in these days of economic nationalism this may be much to Mannesmann's advantage over world markets as a whole. While both concerns have pursued different policies on producing abroad, they have taken the same attitude towards merchanting. They have both been prominent in furthering the eclipse of the merchant and have increasingly concentrated their selling efforts in their own hands. Their market intelligence is thought to be good, and they have been given plenty of opportunity to perfect it in selling in the volatile United States market which is well served by a large, efficient domestic steel tube industry. The largest United States customer (the American oil industry) buys outside the United States only to use up foreign blocked currencies, to encourage local industry for reasons of goodwill, or for marginal quantities in times of peak investment. Both companies have had considerable experience, however, in selling in this market. They both therefore have had plenty of opportunities to develop their sales techniques outside their home markets.

Although they may be well equipped to sell in the Free Trade Area to judge from their experience in the world market as a whole, under the proposed F.T.A. arrangements neither company will be able to work on the assumption that its home market is barred to outsiders. To judge from the 1955 figures, Stewarts and Lloyds have a domestic market of about 500,000 tons a year, much of which is welded general-purpose tubes. Mannesmann have a home market of about 400,000 tons. If these markets are no longer protected, will the steel-tube companies be so bold with their export policies? In the past, much of their steady profit from one year to another has come from these domestic markets which take well over half their output. Will they attack each other's domestic market or will they agree to keep out?

This may be a most difficult and also a most critical decision to take. Being more diversified, Mannesmann might switch its emphasis to steel products other than tubes because of too acute competition in the home market—a step Stewarts and Lloyds cannot take until they diversify further by, say, putting more steel capacity down at Corby to make end-products other than tubes. But questions of flexibility apart, why should not each company agree to leave the others' home market alone, or even come to some tacit agreement about the rest of the Western European market? Table II shows the volume of steel tube exports from the United Kingdom and Western Germany, respectively, to the rest of Western Europe.

The picture given by the figures emphasises the growing strength of the German position (a strength which is less apparent if only global figures are considered). Holland is Germany's biggest customer and takes much more from them than from the United Kingdom. There is, of course, a transport advantage. Scandinavia (already a low tariff area) looks like being a major market where the United Kingdom and Germany may continue to compete severely. The interest of this country and Germany in the other's home market is clearly small as yet. It is possible, of course, that the companies may agree, as in the past, not to invade each other's domestic market.

So long as world demand continues bouyant, both companies may find enough business to keep out of each other's home market on the whole. But each may make forays into the other's back yard if the demand for a particular type of tube temporarily weakens. For example, a temporary lull in the demand for welded tubes of small diameter for general industrial use might lead to attempts to sell in the other's domestic market. To judge from available evidence, the British company is fairly well placed for such border raiding. The figures suggest, however, that the United Kingdom industry by preferring to sell overseas has let the Germans work themselves (and sell themselves) into a tactical advantage in other Western European markets.

The struggle for the Western European tube market will not, however, be fought out by these two concerns in isolation. On the British side, there is the large and powerful Tube Investments Limited to be reckoned with and in Germany, should the Mannesmann challenge falter, there remains the even larger Rheinische Röhrenwerke.

TABLE II EXPORTS OF STEEL TUBES AND FITTINGS TO WESTERN EUROPE (1,000 TONS)

United Kingdom	1954	1955	1956	Western Germany	1954	1955	1956
Western Germany ..	—	—	—	United Kingdom ..	2·2	2·7	2·1
Holland	16·6	19·8	17·7	Holland	42·9	51·8	64·0
Belgium	1·1	3·0	1·2	Belgium	6·1	5·8	6·2
France	0·8	0·9	0·8	France	0·6	0·4	1·0
Italy	0·8	0·7	0·5	Italy	0·9	1·0	1·0
Scandinavia ..	34·7	29·8	32·3	Scandinavia ..	50·5	75·3	60·7
Switzerland	1·3	1·7	2·6	Switzerland ..	20·9	25·1	26·6

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NEW CUSTOMS FOR THE SWISS

It is somewhat surprising to find that at a time when negotiations for the European Common Market and Free Trade Area are well advanced Switzerland is introducing new tariffs. The Swiss are rather self-conscious about this apparently retrograde step, and emphasise that Swiss commercial policies are among the most liberal in the world. Five reasons are given for the present revision. First to bring present tariffs into line with the constitution. Second to increase Federal revenue. Third to modernise the out-of-date terminology of the present tariff schedules. Fourth to give increased protection to certain products. Fifth to give the Swiss Government an efficient bargaining weapon in negotiating with foreign powers.

All these are perfectly sound reasons for making changes. The full details of what the new tariffs will look like will not be available until the end of the year. The emphasis appears to be on increased protection for agriculture and for industries supplying the home market. The Swiss have and will maintain the system of specific duties calculated according to the weight, number or volume of the goods concerned. The present duties average about 10 per cent. by value and this is likely to go up to about 12½ per cent. in the new schedules.

Switzerland is not a contracting party to GATT but has benefited under the most favoured nation clause in some 50,000 mutual tariff concessions made by members. She has every intention, however, to participate in the Free Trade Area and the new tariff will probably serve as the basis for negotiations. Switzerland has proposed that rates at present below a certain minimum should not be lowered during the first round of tariff reductions when the Free Trade Area comes into operation. Should this proposal not meet with agreement the rates concerned will probably be put up to a higher level in the new tariff. In spite of the need for the safeguard provided by this manipulation the Swiss do not want high tariffs. A great deal of their trade is with countries outside Europe and this would suffer if tariffs were too high.

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DETERMINING QUALITY BY ROTE

In order to provide an opportunity for the makers and users of automatic measuring equipment to discuss modern developments, the Society of Instrument Technology, 20 Queen Anne-street, London, W.1, is holding a conference on "The Automatic Measurement of Quality in Process Plants." Research workers in this field are also invited to apply for places at the conference, which will take place at the University College of Swansea from September 23 to 26. Accommodation will be available at Neuadd Gilbertson, the hall of residence attached to the College. The range of subjects that it is hoped to cover will include chromatography, mass-spectrography, pH measurement, and titration, in respect of chemical quality; and density, moisture content, refraction, viscosity, and "consistency," in respect of physical quality.

GUIDANCE IN WELDING

With the object of giving assistance to designers, production and planning engineers, works managers, shop foremen and supervisors concerned with welding and ancillary processes, the British Welding Research Association have prepared a series of illustrated guides covering various processes, methods and designs. The booklets are also intended for use in study and teaching in technical colleges and universities. Some of the matters dealt with in the publications are briefly outlined below.

RESISTANCE WELDING

In general the capital cost of a resistance-welding machine is high and the process is primarily a mass-production one and frequent changes of work should be avoided. High output, however, can be obtained with relatively unskilled labour, particularly on repetitive work.

There are five major forms of resistance welding and these fall into two groups; the first comprises spot welding, stitch and seam welding, roller spot welding, and projection welding. In the second group are butt welding and a development of this, flash welding.

Spot welding lends itself to the assembly of components in which at least one of the parts is a flat sheet at, and close to, the joint. The main features which must be observed in design are to allow sufficient space for the electrodes to approach the joint to be welded and to ensure that the contact areas at the joint are large enough to provide the necessary restraint around the molten weld pool during welding. Normally the contact width should be at least three times the diameter of the weld which is to be made.

The need to seal the edges of a joint adjacent to the molten weld nugget again occurs in stitch and seam welds. Many components are seam welded under water to ensure adequate cooling of the component to avoid distortion and to cool the seam welding electrodes to prolong their life before the deformation of the contour of the wheel or roller electrodes necessitates their renewal and re-machining.

In projection welding several welds can be made simultaneously in the same time that would be taken to make a single spot weld and the electrodes have a longer life between dressings, compared with spot-welding electrodes, owing to the large areas and the relatively low-current density used. The welds are often of better external appearance than spot welds but the process is less versatile than spot welding.

Butt welding is of limited application and when it is applied the two components must have the same shape and area at the contact-faces if a successful weld is to be produced. This also applies to flash welding and the maximum of the unequal areas which can be tolerated is a 25 per cent. increase from the smaller to the larger area.

ARC WELDS

The quality of arc welds depends upon the correct choice of materials, good design, suitable equipment in good condition, correct edge preparation and joint fit, correct welding procedure and sequence, and suitable inspection methods.

Besides all these factors, the quality of a welded joint depends to a very great extent on the skill, efficiency and integrity of the welding operator. The ability of a welding operator should be ascertainted by prescribed tests before he undertakes any work of importance and these tests should be repeated at intervals to ensure that his standard of workmanship is maintained. Apart from the welding process itself, the operator should be able to recognise, and draw attention to, faulty edge preparation, poor assembly and set-up, and equipment which does not provide the correct power supply. The best workmanship, however, cannot be obtained under conditions of discomfort or danger. Careful attention should be paid to the provision of adequate and suitable protection for the welder, including goggles, shields, clothing and gloves, and for others working near him, in the form, for example, of screens or booths. There must be adequate ventilation at the point of welding, but without draughts.

DESIGN OF JOINTS

Among other practical design points, it is emphasised that a butt weld carrying load should generally penetrate the full thickness of the sections joined. Single V, J and bevel butt joints (as described in the " Glossary of Terms Relating to Welding "—B.S. 499) should be sealed. Intermittent butt welds should not be used. The effective throat thickness of an incompletely penetrated butt weld should be taken as five-eighths of the known or anticipated depth or depths of penetration. When pieces of different thickness are to be joined it is advisable to avoid a sudden change of section by tapering the thickness of the heavier member. If the difference in thickness exceeds $\frac{1}{4}$ in., the thicker plate should be bevelled to a slope not greater than 1 in 5.

The length of fillet welds carrying a load should not be less than four times the weld size. For plate thicknesses of from $\frac{3}{16}$ in. to $\frac{3}{4}$ in., the size of the fillet weld should not be less than $\frac{3}{16}$ in., for plates from $\frac{3}{4}$ in. to $1\frac{1}{2}$ in., the weld size should be at least $\frac{1}{4}$ in., for plates from $1\frac{1}{2}$ in. to $1\frac{7}{8}$ in., the minimum weld size should be $\frac{5}{16}$ in. and for plate thicknesses of from 2 in. to 4 in., the weld size should be at least $\frac{3}{8}$ in. If the sizes of the fillet welds are less than those stated, cracking may result. The length of intermittent fillet welds should not be less than four times the weld size. The spaces should not exceed 16 (compression) or 24 (tension) times the size, with a maximum of 12 in.

JIGS AND POSITIONERS

The main purpose of a jig is, of course, to make it easier for a welder to do good work by holding in position the individual parts of a component for welding. Some jigs are simple workshop tools, such as clamps; others are complex mechanisms that also include means for " positioning " the work as well as holding it.

A jig may be a general-purpose tool, carefully designed to operate under many different circumstances or to be simply adapted for similar but slightly varying duties. These are jigs and fittings manufactured and marketed by firms which specialise in this type of equipment. Alternatively a jig may be a specialised device to be employed for the assembly and welding of a particular component, say for mass production, or as a simple tool for one special operation or purpose. These are devices which can be readily designed and made by the firms wishing to use them. The essence of such purpose-made jigs and fittings is simplicity, and this can be attained by ingenuity in design and construction.

Special-purpose fittings and jigs should be, as far as possible, welded fabrications as welding allows the greatest flexibility in design and the use of scrap material. They should also be adaptable, so that after they have served their purpose, it is possible to alter them or incorporate them in other devices for further use. Moreover, they should be competent for the particular task required of them, but they should not be more elaborate or accurate than is necessary.

In the design of the more complex jigs for assembly work there must be free access to all welded joints without the possibility of burning or actually welding the jig or its clamps. Care must be taken to ensure that the heat of welding does not affect the dimensions or stability of the jig or component being welded. Means must be provided for loading and releasing components to and from the jig quickly, positively and accurately and the jig should be designed as an integral unit with no loose parts. Hinges, pins, and screws should be protected from spatter from the welding arc and sufficient tolerance must be available in the jig and its clamping attachments to accommodate the different sizes of unmachined parts without upsetting the accurate alignment of the parts.

Positioners, or manipulators, enable a workpiece to be put into a variety of positions. They are used for both manual and automatic welding and their essential features include stability, accuracy of alignment, accessibility and robustness. Whether rotating, turning or travelling, motor-driven components should be regulated to move at a constant given speed. All movements should be capable of being controlled from one central source and all mechanisms should be designed so that they " fail safe," namely, that the failure of any part or circuit will automatically lock the equipment.

HEAT TREATMENT

Gas-fired furnaces of both the fixed and the portable types and of a range of sizes are widely used for heat treatment. An example of one of the larger gas-fired furnaces is of the bogie-hearth type. It has a length of 56 ft. 5 in., a door opening of 14 ft. by 13 ft. 5 in., and a height to the top of the furnace arch of 15 ft. $6\frac{1}{2}$ in. The average weight of the charge is 50 tons, although the bogie is designed to take up to 100 tons. Such a furnace is therefore capable of normalising or stress-relieving pressure vessels up to 100 tons in weight. Other gas-fired furnaces made in a wide range of sizes, are the portable cover or hood furnaces, in which an insulating-refractory lined hood is lowered into a trough of sand surrounding the base. Electrically-heated furnaces, both of the resistance type and of the induction type are widely used. All operations associated with low-frequency induction heating can be carried out by unskilled or semi-skilled labour and, as the voltage does not exceed 100, the process is considered to be very safe.

It is pointed out that it is doubtful if stress relieving has any beneficial effect on the resistance to fatigue failure of structures made from light sections. It may lengthen the fatigue life of structures made from heavy sections, but this will be mainly due to the tempering of the hardened structures caused by welding in such heavy sections, and not necessarily to the relief of residual stresses. It is emphasised that the application of a stress-relieving treatment does not make safe a weld of poor design, or poor workmanship. Such a weld should be rejected.

ARC-WELDING COSTS

The standard methods of cost measurement and forecasting have frequently proved inaccurate for arc welding. This is due to the many variables involved and the impossibility of standardising all of them. For example, in the case of butt and corner welds, the volume of the weld depends on the joint fit. For fillet welds, however, the volume of the weld is controlled by the welder.

Four methods of dealing with arc-welding costs are considered, namely, that depending on theoretical calculation, that derived from laboratory tests, that in which costs are measured by element time study, and that in which the costs are ascertained by statistical sampling and analysis. The first three of these methods are well known and have severe limitations for arc welding. The fourth method is a new approach which has been developed for the special problems posed by small quantity, highly variable production, of which arc welding is an example. Among other features, this fourth method is based on shop production and, because times are truly representative, the analysis of the variation of times leads to information of value which is not available by the other three methods. Furthermore, the effects of weld volume, electrode size and the welders' rate of working can be measured and forecast separately.

Resistance Welding. By J. E. Roberts. (7*s.* 6*d.*); *Arc Welds in Mild Steel; Production and Inspection.* By C. R. Harman. (2*s.* 6*d.*); *Design of Welded Joints in Mild and Low-Alloy Steels.* By C. R. Harman. (7*s.* 6*d.*); *Jigs and Positioners for Fusion Welding.* By C. R. Harman. (5*s.*); *Heat Treatment of Welded Constructions.* By P. H. R. Lane. (5*s.*); *Arc-Welding Costs.* By A. G. Thompson. (5*s.*). British Welding Research Association, 29 Park-crescent, London, W.1.

FLOW IN PIPES WITH DRILLED HOLES

EFFECTS SIMILAR TO SURFACE WAVINESS

By J. K. O'Sullivan, M.SC., A.M.I.MECH.E.*

An examination of the available data on artificially roughened pipes shows that, with one exception, all the investigations have been carried out on pipes having protuberances (for example, sand particles), fastened to a smooth inner surface; the classical example of this type of investigation is that of Nikuradse[1] in which the pipes were covered with uniform sand particles. The only exception appears to be the investigations of Hopf[2] and Fromm[3] who used channel walls roughened with wire-net, "saw-toothed" zinc plate and "wave-plate." Other experiments, such as those by Stanton,[4] Schiller[5] and Streeter,[6] in which the roughness was formed by crossed screw threads or grooves cut in the smooth surface, may be included in the "protuberance" class.

The experiments described below were carried out on pipes in which circular holes, or pits, were formed in the walls; this type of roughness being, as it were, complementary to the protuberance of roughness.

Two brass pipes were used for the experiments, of nominal diameter 0·9 cm. and 1·6 cm. respectively. The pits were obtained by drilling from the outside through the tube wall. A small broach was then pulled through the pipe to remove the burrs on the inside surface. The pipes were then covered with a waterproof covering. An inner cover of tape was covered with hot bitumen and then bound a second time. It will be noticed that the depth of hole in the pipe is, with this method of roughening, equal to the thickness of the wall.

The holes were drilled in straight rows, parallel to the axis of the pipe and evenly spaced round the pipe. Table I gives particulars of each pipe on which experiments were carried out. The roughening began approximately 50 diameters upstream of the first pressure tapping point and continued 10 diameters downstream of the second tapping point.

Pressure differences were measured with water-air and water-mercury manometers. The fluid used was tap water obtained from a 100 ft. high storage tank and the temperature of the water was measured by a thermometer in a small header tank at the upstream end of the pipe. The flow rates were measured in a calibrated measuring jar for low flows and by weighing for high rates of flow.

When the experiments were completed each pipe was cut into halves horizontally and the holes examined for burrs on the inside which had not been removed by the broach. A measurement of the size of typical burrs, as obtained with the Talysurf[7] instrument, is also given in Table I.

Experiments were first carried out on the smooth pipes, and the smooth pipe law obtained with turbulent flow, to ensure that the pipe bores were initially "smooth" by hydraulic standards. In addition, a Talysurf instrument was used to measure the average roughness of the inner surface of each pipe; these measurements are shown in Table I (h_{av}).

The smooth pipe laws for the 0·9 and 1·6 cm. pipes were, respectively,

$$f = \frac{0{\cdot}0794}{R_e^{0{\cdot}25}} \quad \text{and} \quad f = \frac{0{\cdot}0851}{R_e^{0{\cdot}257}}$$

where f is the friction coefficient in the formula

$$\frac{dp}{dl} = \frac{2 f v^2 \rho}{d}, \quad \text{or} \quad h = \frac{4 f l v^2}{2 g d},$$

TABLE I Dimensions of Pipes on which Experiments were Carried Out

Dimensions of Pipe and Roughening Holes, cm.	Experiment I				Experiment II			
	Ia	Ib	Ic	Dimensions Relative to Inside Diameter	IIa	IIb	IIc	Dimensions Relative to Inside Diameter
Inside diameter	0·909	0·909	0·909	1	1·574	1·574	1·574	1
Outside diameter	1·282	1·282	1·282	1·412	1·898	1·898	1·898	1·206
Length of test piece	105·2	105·2	105·2	115·8	160·0	160·0	160·0	101·7
Entrance length	122·0	122·0	53·0	134[b] 56[c]	160·0	160·0	160·0	101·7
Exit length	40·0	40·0	40·0	44·0	80·0	80·0	80·0	51·0
Number of rows of holes	0	4	8	—	0	4	4	—
Pitch of holes	—	0·417	0·417	0·459	—	0·721	0·721	0·457
Diameter of holes	—	0·198	0·198	0·218	—	0·330	0·450	0·210[b] 0·286[c]
Depth of holes	—	0·186	0·186	0·205	—	0·162	0·162	0·103
h_{av} normal surface	0·00014	0·00014	0·00014	0·00015	0·000029	0·000029	0·000029	0·000019
Height of burrs	0·00023	0·00023	0·00023	0·00025	0·00084	0·00084	0·00084	0·00053

(a) refers to "smooth" pipe. (b) refers to "rough" pipe I. (c) refers to "rough" pipe II. All dimensions in centimetres.

TABLE II Typical Observations in Experiments IIc

(a)	(b)	(c)	(d)	(e)	(f)	(g)
Experiment No.	Corrected Temperature, deg. C.	Time to collect weight in (d)	Weight collected, lb.	Pressure difference, inches of water	Log R_e	Log f
1	15·84	124·9	10	0·30	3·4199	2·0241
2	15·82	111·1	10	0·40	3·4708	2·0473
3	16·70	97·9	10	0·50	3·5336	2·0344
4	16·65	76·4	10	0·85	3·6407	2·0494
5	16·60	68·5	10	1·10	3·6874	2·0666
6	16·54	51·35	10	2·09	3·8120	2·0949
7	16·29	122·6	28	2·95	3·8786	2·1063
8	16·35	93·7	28	5·04	3·9960	2·1053
9	16·38	67·3	28	9·45	4·1411	2·0909
10	16·40	52·5	28	14·89	4·2481	2·0728
11	16·41	41·55	28	22·84	4·3496	2·0552
12	16·49	64·2	56	36·53	4·4627	2·0351
13	15·84	22·6	28	68·73	4·6106	2·0041
14	15·93	17·9	28	103·6	4·7118	3·9802
15	15·90	29·1	56	150·6	4·8016	3·9623
16	15·81	23·6	56	222·6	4·8916	3·9500

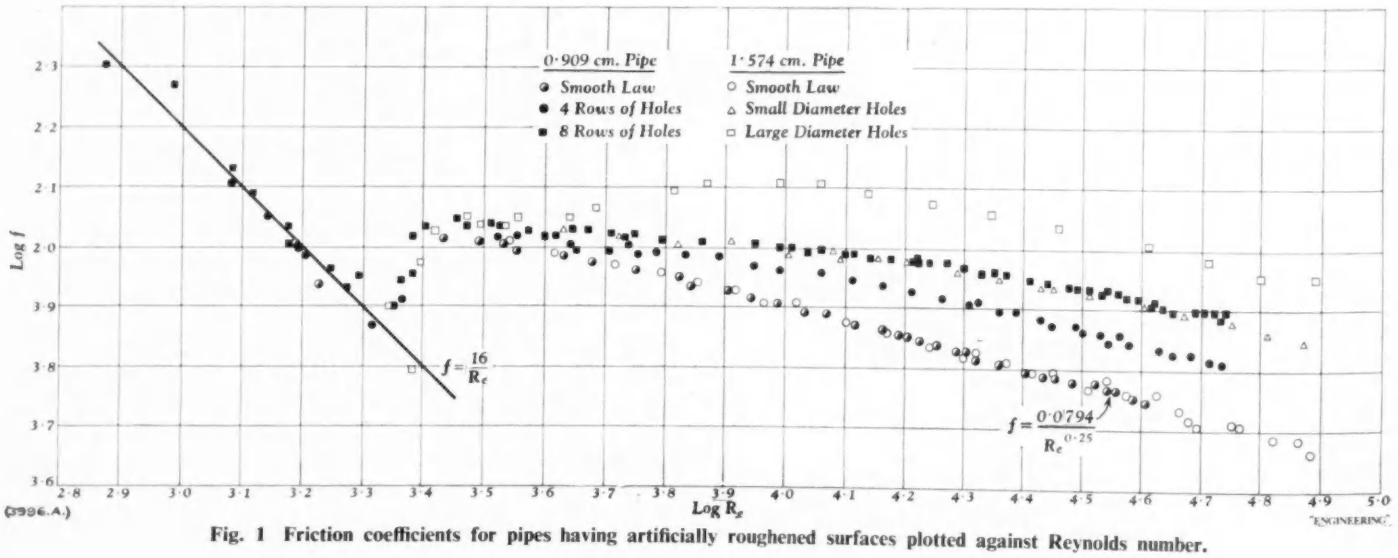


Fig. 1 Friction coefficients for pipes having artificially roughened surfaces plotted against Reynolds number.

* United Kingdom Atomic Energy Authority Industrial Group, Risley. Formerly lecturer in the Mechanical Engineering Department, University of Manchester.

and R_e, Reynolds number, is given by $R_e = \frac{v\,d}{\nu}$, where p is the pressure, l the length of pipe, h the head of fluid, v the mean velocity, ρ the density, d the diameter of pipe, and ν the kinematic viscosity.

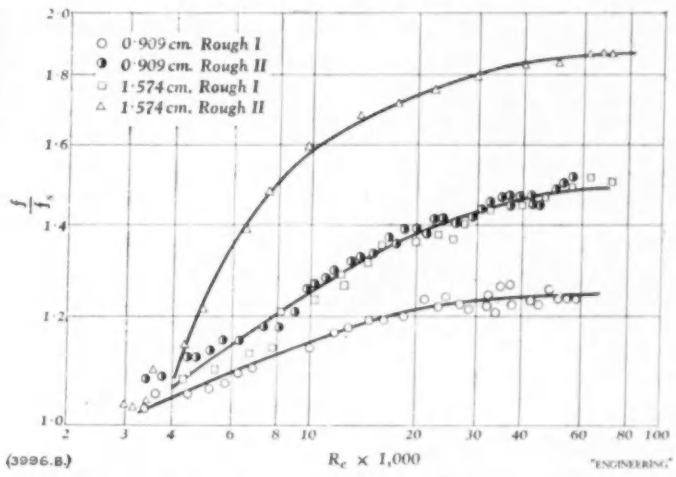
Experiments were next carried out on the roughened pipes and the results of these and the smooth pipe experiments are shown in Fig. 1. On the smaller pipe, experiments were carried out with four rows and eight rows of holes, the size of the holes being the same throughout (experiment Ib and Ic). The larger pipe was first drilled with four rows of holes which were of the same relative pitch and size as those in the smaller pipe, but of a different relative depth (experiment IIb); the holes in the larger pipe were then opened out to study the effect of the diameter of the hole (experiment IIc). Typical observations are shown in Table II. In computing the results, the internal diameter has been taken as the effective diameter, and no correction has been made for the effect of the roughening holes.

It will be noticed from Fig. 1 that there is a tendency for each of the rough-pipe curves to become parallel to the smooth-pipe curve at high Reynolds numbers. With the logarithmic method of plotting used, this indicates a tendency for the friction coefficient of the rough pipes to be a constant multiple of the smooth-pipe friction coefficient at high Reynolds numbers. In Fig. 2 the logarithmic plotting of $\frac{f}{f_s}$ against R_e, where f is the rough-pipe and f_s the smooth-pipe friction coefficient at the same Reynolds number, further illustrates this tendency.

With regard to the effect of each of the variables involved the following observations may be made. Firstly, that if all the other relative dimensions remain constant, a shallow hole may produce a higher friction loss than a deep one. This is supported by experiments Ib and IIb in which the pitch and diameter of the holes is, relative to the respective pipe diameters, very nearly the same in each case, but in which the holes are relatively twice as deep in the small pipe as in the large one. The effect of " depth of roughness " is thus seen to be different with this type of roughness from that encountered with a sand roughness.

By increasing the number of rows of holes from four to eight (with the 0·9 cm. pipe) the value of f is increased by an amount approximately equal to the increase obtained on the smooth-pipe resistance by four rows of holes. There will obviously be some interference when the rows of holes become very close together and this proportional increase will then cease to apply. For adequately spaced rows, however, as in this case, it may be suggested that f is proportional to the number of rows.

Fig. 2 Relative friction coefficients of rough pipe to smooth pipe, plotted against Reynolds number.



An increase in the diameter of the holes, other dimensions remaining constant, has caused the friction coefficient to increase (experiments IIb and IIc). It has not been found possible to study the effect of the pitch of the holes.

It may, therefore, be concluded that if a pipe is roughened with circular holes drilled in the surface, the friction effect is similar to that with the " surface waviness " roughness of Fromm.[3] This effect may be briefly summarised as causing the smooth pipe friction to be increased by a constant multiplying factor at high Reynolds numbers, the multiplying factor depending on the number of holes and the depth, diameter and probably pitch of the holes.

The author wishes to thank the Professors of Engineering for the facilities placed at his disposal in the Whitworth Engineering Laboratories of Manchester University.

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REINFORCED-PLASTICS PRESSURE VESSELS

Among the papers in the " Engineering Design " section of the Reinforced Plastics Conference, held at Harrogate from May 1 to 3 by the British Plastics Federation, was one entitled " Reinforced Plastics Pressure Vessels." It was by Mr. A. Wilson, of the Bristol Aeroplane Company Limited.

The author stated that reinforced plastics materials, chiefly glass-fibre filled thermosetting resins, owing to their high specific strength, presented an attractive proposition to the designer of pressure vessels, and the usefulness of numerous components of these materials was now fairly well established. Under special operating conditions, such as where very hot gases were encountered, asbestos-fibre filled resins found a useful application.

Broadly-speaking pressure vessels could be classified into three main groups according to their method of functioning in service.

The first group comprised the orthodox accumulator or storage type of vessel wherein air or other fluid, both gas and liquid, were charged from an outside source to be stored for use at a later stage for supplying pressure energy or a simple flow of fluid, for aircraft starter systems, pneumatic-hydraulic servo-control systems, oxygen breathing apparatus, and similar equipment.

The second group could be called pressure fluid generators. In this case the pressure fluid was produced within the vessel either as the products of combustion or as the result of chemical action between materials already contained in the vessel. Such components, again, were used with servo and other systems and were also utilised in rocket-propulsion units.

The third group comprised the most commonly known of all, and were used for conducting fluids, from one place to another. These in their familiar form were ordinary pipes or tubes.

Plastics materials reinforced with glass fibres were not isotropic; on the contrary, in their basic form they were highly directional and it was this property which made them particularly adaptable for structures in which a high degree of orientation was desirable. For pressure vessels, however, glass cloths and mats were of little use and lightly-twisted rovings offered the greatest promise. Glass fibres had a potential ultimate strength of over 250,000 lb. (111 tons) per sq. in., though a more useful working figure was considered to be 180,000 lb. (80 tons) per sq. in. What was of prime interest was how much of this potential strength could be realised with the fibres embedded in a glass-resin laminate.

For a sphere, with the stresses uniform in all directions, it followed that the fibres required to be orientated equally in all directions and the problem of orientation resolved itself purely into one of practical application of the fibres. In the case of a cylinder, the fibres were specially orientated to meet any condition of stressing and the simplest method of doing this was to employ a single helical pattern.

Reinforced plastics pressure vessels had recorded hoop strengths of from 85,000 lb. (38 tons) to 100,000 lb. (45 tons) per sq. in. for cylinders and approximately 53,000 lb. (24 tons) per sq. in. for spheres. The results of fatigue tests indicated that, above a certain stress level, the life of a plastics laminate fell off rapidly, and it was significant that the level approximated to the stress at which resin failure was likely to occur. It was apparent, therefore, that although fairly high strength figures could be achieved, it was unwise to base designs on these figures if the compound were to be repeatedly stressed. If, however, these figures were employed a fairly large factor of safety was required to take account of the " scatter " brought about by the failure of the resin. One important point had now become abundantly clear, this being that a resin was required which, either had a higher tensile strength for the same value of Young's modulus or a greater yield point together with a corresponding decrease in modulus.

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TRAINING IN PLASTICS

A record is being compiled by the Plastics Institute of firms in the plastics industry which are prepared to grant day release facilities to their employees, to enable them to study for approved qualifications, such as the diploma and associateship of the Institute.

The registration of pupil-apprentices in the plastics industry is undertaken by the Institute, which issues certificates to such persons as have completed their apprenticeship and technical training in accordance with the details of the Institute's scheme. The scope of this scheme has been made as broad as possible in order to embrace individual firms' own schemes, as well as existing educational facilities in different parts of the country. Thus, the Institute's scheme may include the apprentices of chemical firms manufacturing basic or interim raw materials, or the apprentices of engineering firms producing machinery or tools for use in the plastics industry.

Interested firms are invited to communicate with the secretary of the Institute, 6 Mandeville-place, London, W.1.

Articles Submitted to "Engineering"

A great number of articles are submitted exclusively to us for publication in ENGINEERING. For over 90 years such articles have constituted a valuable and characteristic feature of the journal. However, as a result of the increasing specialisation in engineering and the greatly increased number of such articles that we are now receiving, it has become impracticable for us to publish all those which are obviously of value and reliable in their content. As it would be most unfortunate if we were obliged to reject some of these articles, we have decided to adopt a new policy—a policy which has already been welcomed by those authors to whom we have mentioned it.

Articles which, either because they are much too long or because they are much too specialised, cannot be published in full, will nevertheless be dealt with by means of a longish digest or abstract. (Those which are not too long or specialised will continue to be published in full). The first examples appear below. The length of text is normally sufficient to bring out the main findings or points of the article, but all or most of the supporting evidence is omitted. A photocopy of the full original article is available from ENGINEERING or from the author, as stated at the end of each digest. The advantages of this method, apart from that already mentioned, include, in general, speedier publication and the facility which is granted to the author to focus attention on his results, thereby ensuring the maximum attention being given to his work.

We would emphasise that those articles which are not too highly specialised and are not excessively long will still be published in full if it is believed that this would serve the readers' and authors' interests best. We hope also that with the introduction of this revised procedure some authors who have hesitated to submit articles, theses, etc., to any journal because they know that the articles are of excessive length, will now be encouraged to do so because they know that there is a possibility of an adequate digest being published in ENGINEERING. The Editor will be pleased to give further details of the procedure on request.

REVIEW OF BOILING HEAT TRANSFER

With Particular Reference to Unstable Flow

By J. McNeillis

It is well known that with boiling heat transfer it is possible to obtain a higher heat flux than is the case with single-phase heat transfer. Thus boiling heat transfer finds many applications where high heat fluxes are encountered, but there is a critical heat flux which it is unsafe to exceed and which occurs when the surface being cooled becomes covered with a film of vapour. If the surface generates its own heat (e.g., an electrical heater) the high thermal resistance of the vapour film will cause the surface temperature to rise rapidly and the heater surface may melt. Attempts have been made to correlate the available data so that the heat transfer coefficient and critical (or "burnout") heat flux can be predicted with some success. However, a further complication is possible because under certain conditions the flow of a boiling liquid in a duct may be unstable. The presence of unstable flow may cause an increase or decrease in the heat transfer coefficient and burnout at a lower heat flux than that predicted. It is therefore important to be able to forecast the conditions under which unstable flow will occur.

Pool Boiling.—Bubbles form in a superheated liquid at discrete nuclei in typical shapes depending upon the surface wettability. Little heat goes directly into the bubbles, the high heat transfer rates being caused by the bubbles disturbing the superheated laminar sublayer at the heated surface. The various regimes of boiling are shown in the characteristic boiling curve, Fig. 1. The position of this curve is influenced by the liquid used, the system pressure, the heater surface material, the surface roughness and contamination of the liquid by added agents. Shape, size and inclination of the heater surface have little effect except in the regions of natural convection and film boiling.

The most significant recent correlation of heat transfer coefficient is due to Rohsenow who postulates a bubble Reynolds number and uses it together with a bubble Nusselt number and liquid Prandtl number to deduce his correlation. The critical heat flux has been investigated and correlated by Cichelli and Bonilla and similar results have been found for water by Kazakova and Lukomskii.

Boiling in Tubes and Annuli.—With co-current gas-liquid flow in horizontal tubes, several flow types may exist depending upon the gas-liquid volume ratio and the relative velocities of the two phases; the principal flow types and their distribution are shown in Fig. 2. Lockhart and Martinelli have investigated and correlated the frictional pressure drop in isothermal, two phase gas-liquid flow, their work providing a basis for the correlation of frictional pressure drop in vapour-liquid flow.

With boiling heat transfer in tubes the rate of heat transfer and the pressure gradient depend upon the local flow condition which varies along the tube length. Fig. 3 shows that for decreasing total mass flow an increase in the weight fraction of vapour causes an increase in the pressure drop due to the greater wall drag and the force necessary to accelerate the stream. This pressure drop curve passes through a maximum as the total mass flow continues to decrease, the maximum pressure drop on this curve increasing with heat flux and decreasing with increasing system pressure. There is a relative velocity between the two phases as for gas-liquid flow and a critical mass flow rate analogous to the sonic velocity limitation in the compressible flow of gases. This limitation in the flow rate may, in certain circumstances, prevent the heated tube from being cooled adequately. There is a characteristic variation in temperature of the tube and the stream along the tube length, each plot of temperature against length passing through a maximum.

Boiling in tubes is invariably analysed and correlated by comparison with the phenomena associated with two phase gas-liquid flow, pool boiling and non-boiling heat transfer in tubes. Here again the most significant correlation is due to Rohsenow who considers the heat transfer to be made up of heat transferred by forced convection and heat transferred due to boiling. This method gives correlation of the data to about ± 20 per cent. The critical heat flux has been correlated by various investigators and their equations agree approximately that the critical heat flux depends upon the velocity to the 0·5 power and the temperature difference to the power 1·0. Experimental pressure drop data have been analysed by Martinelli and Nelson who modified the technique of Lockhart and Martinelli by including an approximate allowance for the pressure drop due to the acceleration of the stream. With this treatment the data fell within 30 per cent. of the mean value predicted by the theoretical treatment.

STABILITY OF BOILING HEAT TRANSFER

Of the various methods by which burnout (i.e., overheating) of a heated tube can occur, the following are some of the more important: (1) the occurrence of film boiling in the tube, i.e., when the tube wall becomes covered with a film of vapour; (2) when the rate of turbulence promotion cannot meet the demand of an increase in heat flux and local failure occurs

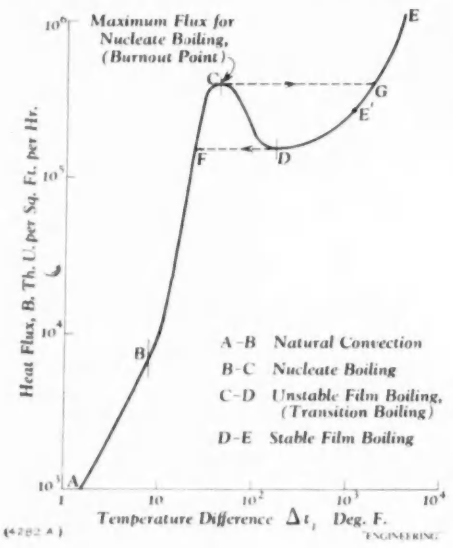
Maximum Flux for Nucleate Boiling, (Burnout Point)
Heat Flux, B. Th. U. per Sq. Ft. per Hr.
Temperature Difference Δt, Deg. F.
A–B Natural Convection
B–C Nucleate Boiling
C–D Unstable Film Boiling, (Transition Boiling)
D–E Stable Film Boiling
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Fig. 1 (left) Characteristic boiling curve.[3]

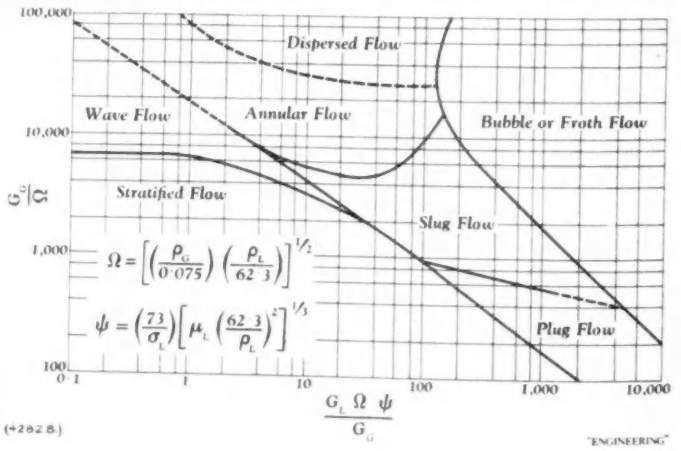

Fig. 2 (right) Principal types of flow and their distribution.[1]

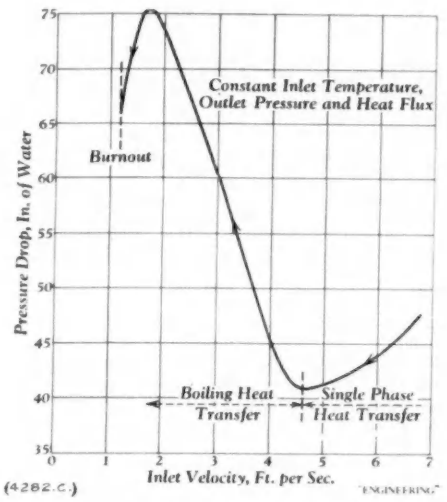

Fig. 3 Curve of pressure drop against inlet velocity.[4]

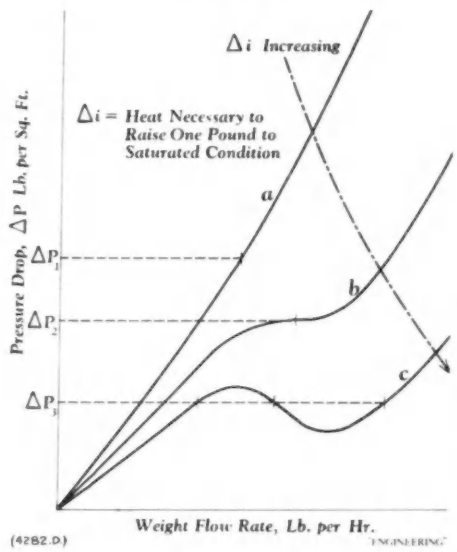

Fig. 4 Curves of pressure drop against weight flow.[2]

suddenly; (3) the occurrence of sonic choking, when the tube appears to boil itself dry; and (4) a hydraulic instability, when the flow fluctuates, and burnout occurs when the flow is at its minimum during a single fluctuation.

The occurrence of unstable flow may increase or decrease the heat transfer coefficient and, since its presence can lead directly to burnout, it is a condition which must be avoided in boiling heat transfer. Fig. 4 shows curves of pressure drop against weight flow, based on the results of an analysis by Ledinegg. The pressure drop shown on these curves is made up of the static pressure loss, the friction loss, acceleration loss, and entrance loss. Each curve applies for a particular inlet subcooling and it can be seen that for the highest subcooling (the lowest curve) more than one flow rate is possible for a given pressure drop. A similar treatment by Profos comes to slightly different conclusions with regard to which parameters influence instability, but the general results are the same. Other kinds of instability exist in boiling heat transfer, a particularly important case being that of parallel connected tubes, when the influence of uneven heat loads may cause instability.

CONCLUSIONS

Various kinds of instability exist depending upon the type of plant considered, the method of circulation and the conditions of operation. For forced circulation the most important fundamental case we may consider is as follows: (1) a single tube uniformly heated; (2) forced convection, in which the direction of flow is assured but the magntitude of the flow may vary; and (3) the inlet liquid temperature is below the saturation temperature (subcooled) and only a fraction of the liquid is evaporated at exit.

The significant analyses concerned with this case agree that instability is most strongly dependent on the preheating required to saturate the inlet liquid (subcooling at inlet) and is also dependent upon the system pressure and the tube friction and geometry. However, there appears to be a disagreement concerning the influence of the total heat supplied to the tube in unit time and the flow rate. Both these analyses indicate that for particular conditions of heat flux, flow rate, pressure and tube geometry, with increasing subcooling at inlet, a critical value of subcooling is reached which marks the onset of instability, but it should be noted that further increase of subcooling beyond this value may cause the flow to become stable again.

Although unstable flow may influence the heat transfer coefficient for boiling heat transfer, the more serious effect is the severe reduction in the burnout heat flux attainable, since this represents a limitation of the boiling heat transfer process. Apart from the theoretical work outlined in the paper, it appears that little experimental work has been done on this type of instability phenomenon and with these considerations in mind experiments are in progress at Queen Mary College (University of London) aimed at further study of the conditions of flow instability.

Note.—The above is a digest of a paper read before Section G of the British Association at Sheffield on Thursday, August 30, 1956. Copies of the complete paper can be obtained from the author at Mech.Eng.Dept., Queen Mary College, Mile End-road, London, E.1.

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EVALUATION OF SEISMIC TORSIOGRAPH RECORDS

By G. S. Pidd, B.ENG.

Marine main propulsion systems consisting of oil engine, transmission shafting and propeller are frequently subjected to torsional vibration caused by variations in engine torque. The method of torsiograph record analysis described below is of particular use where the amplitude of vibration has been measured at a place unavoidably near the node or where it is necessary to determine flank stresses.

Regarding the use of the word "node" it has been pointed out* that while, for instance, in a simple two-mass system with no damping there is a place of zero amplitude of vibration at the node, the effect of a damping torque acting at one mass, i.e. the propeller, is to produce at the node a vibratory amplitude leading the amplitude of the propeller by approximately 90 deg. Accordingly the node should strictly be defined as the place of minimum vibration. Equivalent systems, frequency tables, etc., which may introduce slight errors are not required.

The stresses are obtained directly using only the moment of inertia of the propeller J (lb.-in. per sec. per sec.) the stiffness of the shafting C (lb.-in. per rad.) between the propeller and the position of measurement, and the service brake-horse-power, P_s, and service revolutions per minute N_s, transmitted to the propeller.

At any speed N r.p.m. the torques acting on the propeller arising from an order of vibration n with an amplitude of one radian are

$J p^2$ 1 (a vector leading the amplitude vector by 180 deg.)

and

$k p$ 1 (a vector leading the amplitude by 90 deg.)

p is the circular frequency $= \frac{2\pi}{60} \times N \times n$

k is the damping factor given as an average by

$$k = 28{\cdot}6 \times \frac{\text{transmission torque at N r.p.m.}}{N} = 28{\cdot}6 \times \frac{63{,}000 \times P_s}{N_s} \times \left(\frac{N}{N_s}\right)^2 \times \frac{1}{N}$$

based on the usual assumption that the propeller torque increases as the square of the r.p.m.

The sum of these vectors, which are shown in the diagram, Fig. 1, causes a torsional deflection in the shaft of stiffness C of

$$\frac{\sqrt{(J p^2)^2 + k p^2}}{C}.$$

It is convenient to take for the amplitude vector

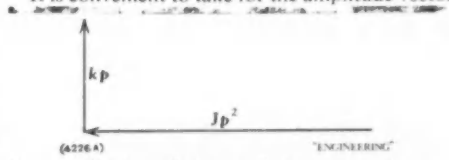

Fig. 1 Vector diagram of torques acting on propeller.

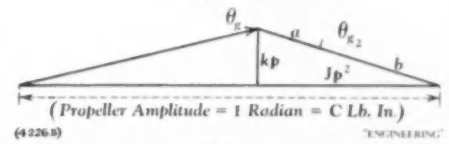

Fig. 2 Vector diagram giving torsional deflection of shaft.

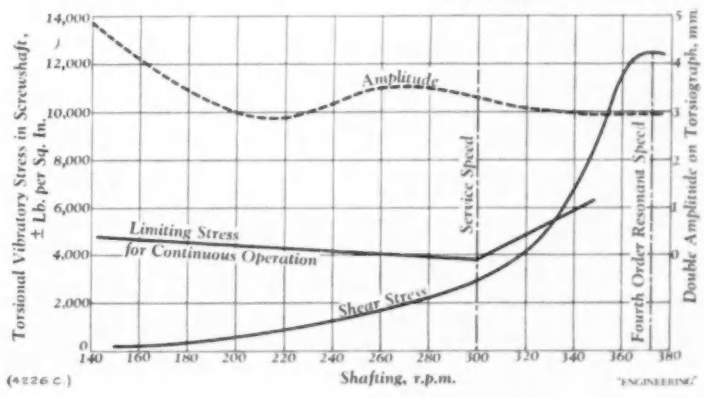

Fig. 3 Torsiona vibratory stress in shaft.

* "Screwshaft Casualties and the Influence of Torsional Vibration and Propeller Immersion," by S. Archer. Institute of Marine Engineers, April 8, 1949.

diagram a scale of one radian = C lb.-in., so that the vector representing the deflection of the shaft coincides with the sum of the torque vectors. The amplitude of the propeller, one radian, is given by a vector of length C. The difference of these two amplitude vectors is the specific amplitude θ_g at the point of measurement for one radian amplitude at the propeller.

$$\theta_g = \sqrt{(k\,p)^2 + (C - J\,p^2)^2} \times \frac{1}{C} \text{ radians.}$$

If the vector diagrams are drawn out to scale it is possible to measure θ_g directly. This lends itself to a simplified method of obtaining θ_g for each of the numerous values of propeller r.p.m. required to plot a smooth curve of stress. It will be seen that the terms $J\,p^2$ and $k\,p$ are both proportional to p^2 or N^2. Thus the angular position of total torque vector remains unchanged, the magnitude being increased or reduced as the square of the propeller r.p.m.

If a second point of measurement occurs on the shaft of stiffness C, dividing it as $a : b$, the corresponding θ_{g2} can be found very easily from the scale diagram as indicated.

In a typical instance in which this method was used a resonant vibration having a peak stress of over ± 12,000 lb. per sq. in. was shown to exist although no trace of this was evident from the measured amplitudes. Both amplitudes and corresponding stresses are shown on the diagram Fig. 3.

Full particulars of this example and an introductory note on the use of vectors are given in the complete article, of which the above is a digest, available from the author, whose address is 72 Broadmead-road, Woodford Green, Essex.

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MINIATURE CIRCUIT-BREAKERS FOR AIRCRAFT

A range of miniature high rupturing capacity circuit-breakers, which have been designed to protect electrical equipment on aircraft is now being manufactured by the Plessey Company, Limited, Ilford, Essex, under licence from Mechanical Products, Inc., Jackson, Michigan, U.S.A. These breakers, which are available in current ranges from 5 to 35 amperes and have a short-circuit rupturing capacity of 7,500 amperes, comply with both British and American aircraft specifications. Compactness is an outstanding feature, as their overall height is only $2\frac{9}{16}$ in. with a width of $1\frac{3}{32}$ in. and a depth of $\frac{11}{16}$ in.

They are of single-pole double-break construction with push-pull operation and the mechanical latches are of hardened steel to ensure long life under manual operating conditions. Particular attention has been paid to the design of the contact system so that effective performance is obtained when short-circuits occur. For that purpose contact pressure is maintained by steel extension springs, which do not carry current, the necessary connections between the contacts and the thermal element being made by flexible conductors. To maintain low contact resistance and provide a self-cleaning wiping action the contacts themselves are mounted on rockers.

The mechanical latches are of hardened steel and the thermal release will break circuit independently, of them even if the operating button is held in the "on" position. Visual indication of the "on" and "off" positions of the breaker is provided by a white band round that portion of the button stem which is only visible when the breaker is in the latter position.

The performance of this new range of miniature circuit-breakers exceeds the requirements laid down in the appropriate American military specification, and tests made in this country indicate that they will be reliable under simulated conditions of violent shock and high altitude.

RE-ARRANGING THE FRENCH AIRCRAFT INDUSTRY

BEFORE reviewing some of the new aircraft that we have seen this week at the 22nd Salon International d'Aéronautique at le Bourget airport, Paris, it may be of interest to record some of the changes that have taken place recently within the French industry. In the United Kingdom there has been much talk of "rationalising" the industry, but suggestions that some of the smaller firms should be absorbed by the larger units have not been received with much favour. In general the existing firms are, understandably, reluctant to lose their identity and prefer to co-operate—as in the supersonic airliner project—as individual units.

In France, on the other hand, a major "rationalisation" of the industry has taken place this year in the merging of the two largest aircraft-producing firms, both nationally owned, into one large company which is claimed to have the largest productive capacity in Western Europe: in January, Ouest Avation (formerly S.N.C.A.S.O.) and Sud-Est Aviation (formerly S.N.C.A.S.E.) united to form Sud Aviation, with a payroll of 22,000 technicians and workmen, 10 factories and a flight test centre with a total floor area of more than 500,000 sq. m.

(Left) The Belgian company SABCA are to take part in the manufacture of Sud Aviation's tactical-support and bomber aircraft, the twin-engine Vautour.

(Below) The Magister military trainer is in large-scale production at the factories of Air Fouga, and is also to be produced in Germany.

By this merger, Sud Aviation expect to make better use of the highly qualified staffs of the two constituent organisations, to concentrate their productive efforts, and to ensure greater continuity of manufacture. Their current activities include production of the Caravelle twin-jet air-liner and two notably successful helicopters, the S.E. 3130 Alouette II and the S.O. 1221 Djinn, and development of a variety of offensive and defensive military aircraft and guided missiles—among which the Vautour bomber and all-weather interceptor aeroplanes—are in production, and a series of ten pre-production Trident II interceptor aircraft are under way.

The French are taking a leading part in fostering co-operation between the aircraft industries of Europe. France is one of the member countries of the Association Internationale des Constructeurs de Matériel Aéronautique—the other members of which are Belgium, Denmark, Germany, Holland, Italy, Norway, Spain, Sweden, and Switzerland. In addition to this general movement towards European co-operation in research facilities, design and production methods, and finance, there are moves towards international tie-ups between individual companies.

Some months before the amalgamation of Ouest Aviation and Sud-Est Aviation, an agreement was made between the former company and Société Anonyme Belge de Constructions Aéronautiques whereby the Belgian company were to take part in the manufacture of the S.O. Vautour tactical support and bomber aircraft. Another important international link-up was made early in 1956 between Louis Breguet and the Dutch Fokker companies in which the two firms agreed, so far as possible, to avoid competing with each other over aircraft designs, to share commercial representation, to exchange "know-how" and to co-operate in aircraft production whenever this appeared to be advantageous. Breguet's diverse activities include the production of large transport aircraft, and currently they are concerned, among other things, with the development of supersonic tactical fighters, anti-submarine aircraft and super-circulation research aircraft. The principal current product of Fokker, which seems destined to an international future as a D.C.3 replacement, is their Friendship turbo-prop airliner.

Another large internal reorganisation has taken place in respect of the Fouga company who developed the internationally successful Magister lightweight jet trainer. A reconstituted corporation, Air Fouga, was formed in September last to take over the aviation factories of the Fouga concern, in which equal shares were taken by Breguet, Dassault, Morane-Saulnier, and the two constituent companies of Sud Aviation (before the formation of the latter). A new factory has recently been con-

structed in Toulouse for Air Fouga who have a contract for 1,000 Magisters. Magister aircraft are also being built in Germany by the Messerschmitt and Heinkel companies, and the Grumman corporation in America has taken an option on a licence to construct them in the United States.

In the engine world, a new Compagnie Générale de Turbo-Machines (C.G.T.M.) was set up in April last year, under an agreement between the Hispano Suiza and Turboméca companies, to carry out development work related to the application and production of turbine engines. Hispano Suiza entered the gas-turbine field after the war by way of agreements with Rolls-Royce Limited under which they constructed Nene and Tay engines under licence, and from thence went on to their own developed version of the Tay, the Verdon, and then into prototype design—and are now entering the nuclear energy field. Turboméca, on the other hand, initiated a new conception in gas-turbines in a series of low-thrust engines and small compressed-air generators that have put France into the leading position as regards the design of high-performance lightweight aircraft.

Next week we propose to describe some of the technical developments seen at the Salon.

"CIVIL VICTOR" AIR-LINER PROJECT

18 *Ton Payload and Cruising Speed of* 600 *m.p.h.*

Among the long-range airliners that have been assessed but have not been selected by British Overseas Airways Corporation is a project developed by Handley Page Limited, Cricklewood, London, N.W.2. This aircraft, the Civil Victor, has been designed particularly for Commonwealth routes but, with additional tankage, it should have an excellent performance on non-stop transatlantic services between London and New York.

Powered by four Rolls-Royce Conway engines, the Civil Victor will carry a payload of nearly 18 tons and will cruise at over 600 m.p.h. Its take-off and landing runs are moderate by present-day standards, and it would be able to operate from existing airfields without need for extending their runways.

The Civil Victor will carry a maximum of 172 passengers in a double-deck fuselage over stages such as London to Rome. Between Rome and Nairobi, 3,414 miles apart, it will carry 109 passengers in 6 hours 36 minutes. Flying the 2,938 miles from Singapore to Karachi, the Civil Victor will take 5 hours 50 minutes and carry 126 passengers.

The wings and tail unit of the new airliner have been proved both structurally and aerodynamically, for they are those of the Victor, as are also the flying controls, systems and services. The two-deck "double-bubble" fuselage is designed to ensure the best use of its large internal volume. Two spiral staircases connect the decks.

The Civil Victor has three passenger-entry doors, two of which are on the upper deck, and one baggage door. There is a large freight door at the rear of the lower deck. Doors are located so that the greatest number of service vehicles, such as buses and lorries, can approach the aircraft simultaneously to speed the loading of passengers, baggage and freight.

The leading particulars of the Civil Victor are as follows: wing span, 126 ft.; overall length, 126 ft. 3 in.; overall height, 33 ft.; fuselage length, 112 ft.; external fuselage width, 12 ft.; total fuselage volume, 11,250 cub. ft.; usable fuselage volume, 9,850 cub. ft.; freight and baggage volume, 860 cub. ft. The internal wing tanks have a fuel capacity of 8,000 gallons and an additional 2,600 gallons in tip-tanks.

The long-range version will have a total usable fuel capacity of some 12,000 gallons. The maximum take-off weight is 214,000 lb., the maximum landing weight 160,000 lb., and the maximum payload 40,000 lb.

At the maximum take-off weight of 214,000 lb., an airfield length of 2,040 yards will be required. The aircraft will climb to 30,000 ft. in 8 minutes, and at that height the rate of climb is 2,500 ft. per minute. The cruising speed at 40,000 ft. is estimated to be over 600 m.p.h.

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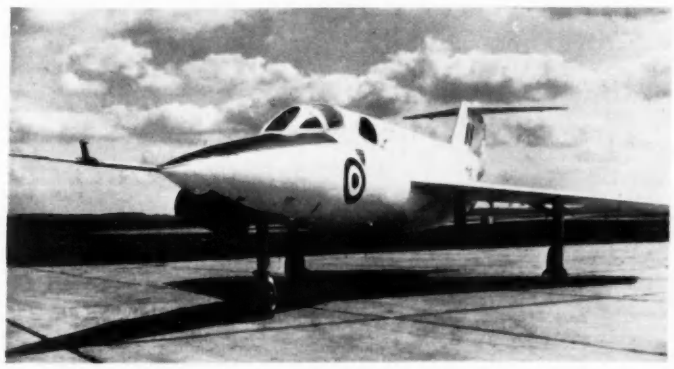
U.K. ROCKET-TURBOJET AIRCRAFT FLIES

Shown in the accompanying illustration is the first—and probably the last—British "mixed power" interceptor research aircraft, the SR3, designed and constructed by Saunders-Roe Limited, East Cowes, Isle of Wight, which recently made its maiden flight at the Aeroplane and Armament Experimental Establishment, Boscombe Down. The SR3 was designed with the idea that it would ultimately be the replacement for the P.1 supersonic fighter. According to the new thinking on defence, outlined in the recent White Paper and discussed in the article in our columns last week, there will now be no manned successor to the P.1.

The SR3 is powered by an Armstrong Siddeley Viper turbojet—the intakes for which can be seen flanking the cockpit—and a de Havilland Spectre liquid-fuel rocket motor. The latter enables the interceptor to maintain a very fast climb up to its operating altitude, whereas with turbojet power units alone the rate of climb would fall off as the turbojet thrust diminished with the decreasing air density. At the operating altitude, the high thrust of the rocket, with its self-contained oxidant supply, enables the interceptor to accelerate to high supersonic speed for a short period at a comparatively small cost in power unit weight. It also improves the manoeuvring ability of the aircraft during interception. For cruising, the turbojet alone will be used.



The first British mixed-power machine, the SR3, recently made its first flight. The rocket motor will enable it to move at supersonic speeds at the operating altitude.

The Handley Page "Civil Victor."

COMET 4B FOR CONTINENTAL ROUTES

A new and more economical Comet variant, the 4B, with a larger seating capacity, has been announced by the de Havilland Aircraft Company Limited, Hatfield, Hertfordshire.

The principal changes in the Comet 4B, as compared with the Comet 4A, are an extension of the fuselage by 38 in. and a re-arrangement of the seating plan to allow for two extra rows of passenger seats; also the removal of the wing nacelle tanks, resulting in both lower fuel consumption and landing speed. The increased space available in the Comet 4B fuselage makes it possible to accommodate up to 99 passengers in the tourist-class layout, while a first-class version is proposed to seat 84 passengers.

The Comet 4B has an all-up weight of 152,500 lb., the same as the earlier version. For maximum speed over short stages the aircraft can be flown at medium altitudes, cruising at speeds of between 520 m.p.h. and 545 m.p.h. (depending on temperature) its optimum altitude for this purpose being 23,500 ft. With this operating procedure the Comet 4B could operate over stages of from 300 to 2,000 miles.

The alternative method of cruising in which the aircraft is climbed to 38,000-42,000 ft. and cruised at 490 to 500 m.p.h. will extend the stage length to about 2,600 miles with the same payload. For ready comparison the Intercontinental Comet—that is, the Comet 4 as being built for B.O.A.C.—has a stage length of about 3,000 miles carrying its capacity payload of 60 first-class passengers and freight.

The operating costs of the Comet 4B have been calculated and, on the basis of European operation, it is found that with first-class seating, the cost per seat-mile varies from 1·4*d.* on the longer stages, to about 2*d.* on a representative 500 mile stage. Thus, it is claimed, the Comet 4B is competitive with turboprop aircraft some 100 to 150 miles per hour slower.

To facilitate a quick turn-round at intermediate halts the Comet 4B short-range aircraft can be provided with equipment which would make it virtually independent of ground equipment, reducing the stop-over to a few minutes.

ASSEMBLING TRANSISTORS

SOLID DIFFUSION AND THE ALLOYING OF VERY SMALL PIECES OF METAL

A man walked in front of a mirror and a light came on. The equipment containing the mirror and light detected the infra-red radiation due to body heat. No light beam was broken—as in the conventional photo-electric system. For, whereas the latter system requires a separate light source in order that a body may be detected when it comes between the light and the photo-cell, the infra-red system is self-contained in one unit. Mullards' new factory at Southampton was the scene of the demonstration. A piece of lead telluride immersed in liquid oxygen made the demonstration possible. The detection of the infra-red radiation of an aircraft's engines is one way in which a guided missile can be made to home on the aircraft.

Lead telluride is a semi-conductor. Semi-conducting devices—diodes, transistors, etc.—have already superseded vacuum tubes in certain applications and promise to come into even greater use. Their low power consumption and small size make them very suitable for portable equipment. Among other fields of application are computing and automatic telephone exchange techniques. A market survey carried out by the Stanford Research Institute indicated that in the United States transistor production was likely to increase almost five-fold in the next three years. In France, also, a large increase is expected—one firm, Société Française Radio-Electrique, recorded a 20 per cent. rise in sales last year and is spending about £500,000 to expand transistor production. Mullard, Limited, Torrington-place, London, W.C.1, are similarly aware of the increasing demand for semi-conducting devices, as their plans for the establishment of a completely independent centre for manufacture show. So far, only about one-third of their new plant has been completed, but a form of construction has been used that enables each section to be occupied as it is completed. The production programme is based on an estimated output of several million semi-conductors of all kinds for 1958. Of these, a considerable proportion will be transistors. The present staff is about 400, of whom 60 are graduates. Employment figures will eventually rise to between 1,500 and 2,000.

The mass production of transistors raises many problems that have not been encountered before by industry. There are two production lines in operation at the Southampton works. Neither is mechanised to the full extent possible. Techniques are changing so rapidly in the field of semi-conductors that the chief requirement of a production line is that it be able to adapt itself readily to new methods. The high purity required of the materials used, the small size of the assembled component, and the degree of control required in the various heating processes give rise to the principal problems, and their solution gives the production lines their distinctive character.

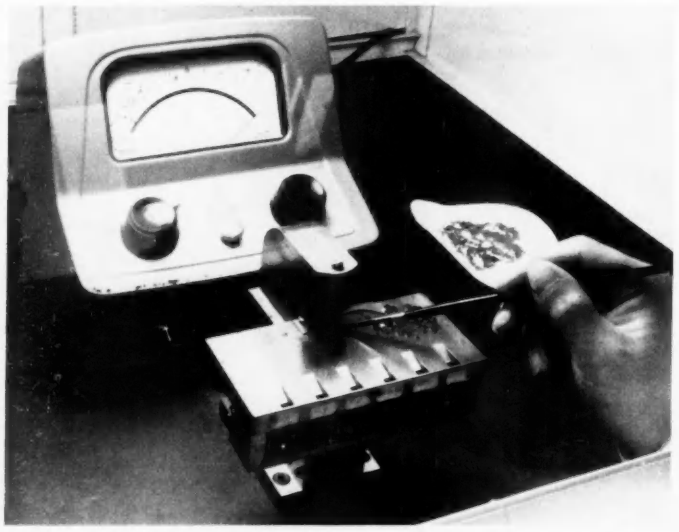


Fig. 1 The wafers of germanium, forming the principal part of a transistor, are accurately measured by an electronic technique. Surface contamination of the germanium must be avoided and for this reason the measurement is carried out in a dust-free box.

The building in which the lines are situated is quiet, well lit—chiefly by natural light from windows in the roof, aided by the widespread use of light colours—and clean. The benches carry a high proportion of instrument equipment, and in addition to the more conventional gas, water and electrical supplies, have supplies of compressed air, nitrogen and hydrogen, and a vacuum line.

COMPOSITE SINGLE CRYSTAL

Transistors depend for their operation on the creation of sharp boundaries between two different types (*n* and *p*) of semi-conductor. The different types must be in the same crystal, and the boundaries, or junctions, as they are more usually called, can be produced in several ways. The technique adopted by Mullards in the production of the OC72 transistor is to form an alloy or fusion junction. Pellets of indium are fused on to both sides of a wafer of *n*-type germanium. An indium-germanium alloy is formed and the indium also diffuses for a short distance into the germanium, and in doing so produces a region of *p*-type germanium. By careful control, a *p-n-p* transistor with well-defined junctions within a single crystal can be obtained. The two *p* regions are made different in size, the larger being called the collector, the smaller the emitter.

In thermionic valves electrons are manipulated in a vacuum. In transistors the electrons move in a solid. To ensure that spurious effects do not occur within the solid, it must be homogeneous. Imperfections in the crystal structure must be kept to a minimum. Checks can be made on the crystal structure by X-ray and electron-microscope techniques, both of which are available at the new plant. Since the electrical properties of semi-conductors are markedly dependent on the amount of impurities present, rigorous control of chemical composition is essential. At one stage in the manufacture of a transistor, germanium with a purity of 1 part in 100,000,000 is required.

One of the chief disadvantages of the germanium transistors at present available is their sensitivity to temperature changes. Mullard hope to produce a silicon transistor soon that will be able to operate over a wider temperature range. Research is also being carried out on other materials. Indium and antimony are close to germanium in the periodic table of the elements and they form intermetallic compound that is similar in some ways to germanium while having some interesting properties of its own. Indium antimonide has useful photo-electric properties. Like lead telluride it can be used for infra-red detection. But whereas lead telluride must be kept at the temperature of liquid oxygen if it is to operate successfully, indium antimonide will operate at room temperature. Its melting point of 520 deg. C. is useful, comparing very favourably with that of silicon, which melts at 1,420 deg. C. An incidental property it has is that two pieces may be cold welded merely by rubbing them together.

Fig. 2 After the pellets of indium have been fused on to the germanium wafer, a connecting wire is welded to the nickel base ring.

PRODUCTION PROCESS

However, germanium is still the most widely used material for transistors. The first step in

manufacture is to purify the germanium by zone refining, a heat process using induction heating. An ingot of germanium is loaded into a graphite "boat," which travels through a silica tube. A series of radio-frequency inductor coils encircle the tube at intervals along its length, and as the graphite boat passes along the tube each coil produces a molten zone in the germanium. Since the solubilities of any impurities present are greater in liquid than in solid germanium, the impurities collect in the molten zones. As the ingot travels through the successive coils, the impurities are swept along the ingot until they are concentrated at one end, which is discarded.

After purification, the ingot of germanium consists of many small crystals of different sizes and orientation. The ingot is next transformed into a single crystal. This is done by mounting the ingot in a silica boat, along with a short length of single-crystal germanium, which is used as a seed. The loaded boat is then placed in a furnace and the region of contact between seed and ingot melted. By moving the boat slowly through the furnace the molten region is extended along the ingot, the original seed crystal growing behind it, so that eventually the ingot consists entirely of a single crystal.

Fig. 3 The connecting wires to the indium pellets which form the emitter and collector of the transistor are attached by soldering in a stream of hot gas.

Transistor germanium must have a certain value of resistivity, depending on the particular type of transistor for which it is intended. Resistivity is governed by the amount of impurity contained in the ingot, and a calculated quantity is therefore added during the melting process. The added impurity determines the type of semi-conductor produced.

The next step is to machine the single-crystal ingot into wafers of suitable size and shape. First the bar is cut into very thin slices by a fast-rotating cutting wheel. The slices produced in this way have a thickness of about 0·5 mm. For use in a transistor such as the OC72 the slices are lapped to 0·35 mm. and cut into dice approximately 2 mm. square. The material is then reduced to a thickness of 0·15 mm. by etching. The wafer is measured for correct thickness by an electronic method (Fig. 1) which is accurate to ± 0·5 micron. The emitter is formed from discs of indium containing 0·5 per cent. gallium. The discs, which are originally 0·1 to 0·15 mm. thick, are stoved in hydrogen to form spheres, etched and weighed. The collector which is pure indium is treated the same way.

The transistor is assembled on a nickel base. Carbon jigs are used. The germanium is placed in a socket in the jig and the nickel strip is placed above it. The top of the jig is put in place and the collector pellet is put on top of the germanium through a hole in the top of the jig and the nickel base. The pellet is then alloyed to the face of the germanium in a multi-stage furnace containing a controlled gaseous atmosphere. The jigs are turned over and the process repeated for the emitter pellets. A furnace temperature of between 450 and 500 deg. C. is used. Some idea of the size of the alloyed dice can be gained from Fig. 2, where the process of welding the nickel base to the appropriate connecting wire is shown. The three connecting wires are sealed into a glass foot in a previous operation. Before attachment the wires are tinned in a rotary tinning device. The tinning is done in such a way that a small flag of solder is made to facilitate connection. The soldering, shown in Fig. 3, is achieved with a stream of hot gas. The operation is very critical and requires the aid of an optical magnifier.

Surface effects in semi-conductors are very pronounced, and it is essential that surface contamination be removed. The transistor assembly is therefore chemically etched. An electrical test follows to ensure that the transistor has the correct characteristics before it is encapsulated. To prevent any subsequent contamination the pre-test is made in a hermetically-sealed "dry box," Fig. 4, containing a nitrogen atmosphere of controlled humidity. The transistors are now ready for their envelopes. These contain a special grease which protects the transistors from moisture. The encapsulation process is done in a controlled humidity chamber.

Finally, the electrical characteristics are rechecked and the transistor prepared for shipment.

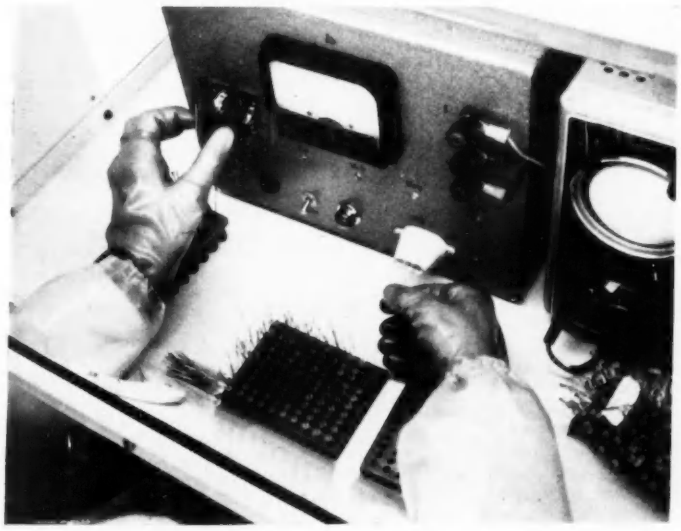


Fig. 4 Before encapsulation, the electrical characteristics of the transistor are checked. To avoid contamination the operation is carried out in an atmosphere of nitrogen.

SOLVING PROBLEMS BY ANALOGUES

Electrolytic Tank for Flow Studies

Although the equations of magnetic and electric fields can look deceptively simple, their evaluation in practical problems can be extremely difficult. Often a theoretical solution becomes virtually impossible. However, when the problem concerns static fields it is formulated in the equations of Laplace or Poisson and consequently can be regarded as a particular case of a much more general problem; for these equations can govern the behaviour of liquid flow, heat flow, the distortion of thin rubber sheet, the flow of electric current through a liquid, etc.

Advantage is taken of this generality by the use of analogues to solve electrical or magnetic problems. For example, the distribution of the electric field in a complex vacuum-tube structure can be studied by stretching a thin rubber sheet over a wooden model of the electrode structure. Only a two-dimensional solution can be obtained in this manner, and a number of precautions have to be taken to secure a result of a reasonable accuracy.

A more successful analogue for the investigation of such problems is the electrolytic tank. A paper* by Mr. E. R. Hartill, Mr. J. G. McQueen, and Mr. P. N. Robson describes one such instrument and gives details of the uses to which it has been put. The distribution of the potential gradient around a cap-and-pin type suspension insulator string was investigated and as a result of the findings a new type of construction using mixed dielectrics was advocated.

An investigation was also made into the design of drift tubes in a resonant-cavity proton accelerator. In this instance the solution of an electromagnetic boundary problem was reducible to an electrostatic problem, which could be solved with the tank. The evaluation of the radial and axial components of the electric field near the axis of the accelerator allowed the behaviour of the accelerated protons to be studied. Both of the foregoing problems were treated as three-dimensional. A two-dimensional problem—the flux distribution of a synchrotron magnet—was also studied. The tank could also be used to derive solutions to problems occurring in civil and mechanical engineering, such as stress distributions.

The procedure in the electrolytic tank is to construct a model of the structure to be studied and to suspend it in tap water. Generally, the surface of the model is conducting and forms one electrode, while the walls of the tank form the other electrode. However, other arrangements are possible. The chief components of the apparatus are a travelling probe and a feedback amplifier. The probe measures the potential of the water immediately surrounding it. When the probe is allowed to move through the liquid, but its motion is governed by the feedback amplifier so that it moves along a line of constant potential. The path taken by the probe is drawn on a full-scale diagram of the electrode arrangement. Sets of lines are traced until the whole field distribution is obtained to the accuracy required. The feedback amplifier compares the potential of the water at the probe with a pre-set bias potential, and moves the probe in such a manner that the error between the two is minimised. If electric field strength is required instead of potential, the probe is equipped with two electrodes, and the potential gradient between the two is used as the criteria for the feedback system. The tank described by the authors uses square-pulse excitation of small pulse-space ratio. Consequently the tank current between pulses is extremely small and the polarisation rate between pulses is slow. For most practical investigations accuracy is about 1 to 2 per cent.

* "A Deep Electrolytic Tank for the Solution of 2- and 3-Dimensional Problems in Engineering." To be published in volume 104, part A, of the proceedings of the Institution of Electrical Engineers.

Book Reviews

AIDS TO BETTER INDUSTRY

Industrial Trade Associations: Activities and Organisation. *Political and Economic Planning*, 16 *Queen Anne's-gate, London, S.W.*1. (30*s.*)

Starting in October, 1953, a PEP group, whose members were drawn from industry, trade associations, the professions and the universities, investigated the structure, activities and organisation of national associations in the manufacturing industries. The inquiry covered a total of some 1,300 associations, as existing in 1955, and this register gives a full list of them, classified according to the Standard Industrial Classification.

In a short introduction, the group states the sources it used for obtaining material as being the trade associations themselves, other organised bodies, Government departments and individual firms. Evidence of the advantages accruing from this wide range of informed opinion is to be found in the balanced presentation offered. "Evidence" may be an apt term to employ in this connection, as there is always a tendency for critics to make accusations against associations, trade unions and similar corporate bodies. PEP has done a great service in collecting the facts on which to form judgment and assess relative values.

In the first chapter, an account of the history and structure of the associations generally is followed by more detailed attention to certain of the larger and more important bodies. Study of Appendix B, which lists the 250 incorporated manufacturing associations registered as public companies, shows an interesting growth pattern. Thus, one of these bodies, the Pianoforte Manufacturers Association, Limited, was registered as long ago as 1892, but, even by 1913, there were only 27 such bodies on the register of companies. A further 38 associations were incorporated by 1923; no less than 21 of them being formed in 1919-20. Then followed a period of steady growth, with another marked acceleration from 1940 onwards, giving a total of 250 registered associations in 1955. Recognition of this pattern demands attention being given to its significance, and the editors give a clear account of the developments which resulted from the necessity for organisation by industry, when conditions imposed restrictions on their activities and brought new responsibilities.

Although these conditions arose during and after the two wars, it is of special importance that the value of trade associations to governmental and representative bodies, to which information might be given and from which it might be received, became apparent. The advantages then found to exist have continued to favour the formation of bodies with representative functions, which can act as channels of communication with the Government and with other organised bodies. Trade associations can and do fulfil this function. Ideally, another main activity of these bodies is the provision of common services to improve the efficiency and marketing knowledge of their members. It is shown in this publication that the middle-sized and larger associations are able to offer highly valuable guidance on such matters as the promotion of exports, import licensing, traffic regulations, and consultations prior to trade negotiations with foreign countries. It is, however, open to question as to whether the costly duplication of services arising from the existence of over-specialised associations, themselves frequently small, is justified. There must be occasion for an examination of the logic of applying rationalisation to the trade associations themselves.

Their purpose of serving as clearing houses for commercial information is one which merits extension to include technical matters. This is not to suggest that the nation's already overdrained pool of technologists should be further drawn upon to create staffs of experts for associations which have other defined purposes. It should be possible for "restricted information" to become a term as condemnatory as that of "restricted practice." There is already much waste of effort in Great Britain, due to outmoded ideas of secrecy which prevent the practice of mutual help. Trade associations might well encourage their members to seek and supply information for interchange over a much wider field than at present, and provide the machinery for that purpose.

It is known that the Federation of British Industries itself has technical officers competent to guide that Federation and its members in matters calling for specialised knowledge. Provided that such aspects of an association's work extends the use of information, and does not over-use trained personnel, the extension of services of that nature might usefully be encouraged. It is a case of co-operation requiring to be practised to the fullest degree attainable.

Recognition is due to the part which trade associations have been able to play in the formation of research associations under the joint sponsorship of the trades concerned and the Government. Another function which is capable of extension is the spread of appreciation of the advantages of work-study techniques and the application of instruments. These means of increasing productivity are quoted as pointers to what associations can do (and, in some cases, are doing) in extending the proved methods of well-regulated firms to the less efficient ones.

The protection of inefficiency should increasingly be removed from the policy of even the most short-sighted associations. Many trade organisations, by their constitutions, have imposed limits upon themselves, providing that prices, and even wages, are not to be their concern. On the other hand, the coming into force of the Monopolies and Restrictive Practices Act, 1956, has caused some trade associations to go out of existence.

The writers of the book have assembled the facts fairly and comprehensively, and have added a reasoned statement of their own conclusions. Study of the work is recommended to executives and others engaged in industry and commerce, and, given the same objective approach as the authors have adopted, benefits will surely follow. Among these benefits may be the contribution which can be made to the improvement of the industrial trade associations themselves.

HUMIDITY MEASUREMENT AND CONTROL

Hygrometry. By H. SPENCER-GREGORY and E. ROURKE. *Crosby Lockwood and Son, Limited*, 26 *Old Brompton-road, London, S.W.*7. (36*s.*)

How to measure the concentration of water vapour in a gaseous atmosphere is the subject with which this new work mainly deals. A particular welcome is due, for this is the first major British work for some years to be devoted to this "backroom," but no less important, branch of scientific measurement.

While the authors, who are accredited experts in this subject, write as physicists, it must be remembered that the applications of hygrometry to engineering are numerous and direct. In aerodynamic research, upon which aircraft development so largely depends, the practical significance of costly wind-tunnel tests may hinge critically upon a knowledge of the humidity of the circulating air. Industrial manufacture is concerned with humidity: certain textile processes demand a high degree of it; while inspection and standards rooms may well abominate it. Concrete technology, sewage treatment, chemical and biochemical manufacturing processes, and the heating and ventilating of buildings are but a few more in the list of interests which commerce is bound to take in this rather unassuming facet of science.

An interesting historical preface is supported by a careful bibliography. Then follows a comprehensive introductory chapter in which all relevant physical principles are discussed qualitatively: basic phenomena are thus treated, and the workings of various types of hygrometer are described—ranging from the ancient hair instruments to the most up-to-date electrolytic devices; nor is the topic of humidity control (as distinct from measurement) neglected, for much useful information is included. The ensuing nine chapters of the book review and amplify these various topics in fuller detail; a function which is assisted by liberal illustrations, three appendices and 17 tables of valuable numerical data. While a few literary lapses occur, the general exposition is clear and the typographical layout attractive: the mathematical content is nicely adjusted to its task of turning qualitative into quantitative, and never overruns into the sort of academic fugue that makes subject matter needlessly complex and pointlessly impressive. A chapter of special interest is that devoted to the moisture content of highly-compressed permanent gases, and in this some of the less familiar aspects of hygrometric theory are brought to light.

It would have been appropriate in a book of this kind to include some discussion of supersaturation phenomena and the relationship which hygrometry bears to experimental gas dynamics, but perhaps a future edition will be able to fill this gap. Similarly, some future paragraphs might usefully be included to show how the principles of hygrometry may be applied to describe the behaviour of any vapour-and-gas mixture; for, in the growing range of engineering interest, there are mixtures in addition to that of water vapour and air which periodically call for understanding.

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NEW BOOKS

Electrical and Optical Characteristics of D.C. Corona Discharges in Air at Atmospheric Pressure. By B. MURPHY. *The British Electrical and Allied Industries Research Association, Thorncroft Manor, Dorking-road, Leatherhead, Surrey.* (21*s.*)

Direct-current positive-point to plane corona discharges in untreated room air have been studied with the aid of a photo-multiplier, wide band (distributed) amplifiers and a high-speed C.R.O. The results indicate that a pulsed form of discharge did not necessarily occur. When a pulsed form did occur, the pulses were associated with streamers propagating from the positive point towards the negative plane. The direct evidence shows that some ionisation and considerable excitation occurred ahead of and around the streamers. All the results could be explained satisfactorily on the latest ideas of the streamer theory, when due consideration was given to increase in the excess positive space charge in a streamer as it began to die away and electrons were removed from the channel. The exact mechanism initiating a streamer is described as obscure.

British Plastics Year Book, 1957. 27th edition. *Iliffe and Sons, Limited, Dorset House, Stamford-street, London, S.E.*1. (42*s.*)

There are nine sections in this latest edition of the *Year Book*. Three are devoted to classified lists of manufacturers and suppliers of materials, finished products, and equipment. Other sections comprise lists of proprietary names and technical terms, prominent persons in the industry, trade associations and federations, recent patents, new companies, and specifications, and technical and general data applicable to the plastics industry. Each section is prefaced by a tabbed card to facilitate reference.

Modern Techniques of Excavation. By HERBERT L. NICHOLS, JR. *Odhams Press, Limited*, 96 *Long Acre, London, W.C.*2. (70*s.*)

This book is of United States origin and like most books from America it does not set out to do jobs by halves. This one describes the method of working

and the equipment required for all excavation jobs from digging out for a new garden path or tennis court to mucking out for a coal mine or canal. In passing, chapters deal with surveying, blasting, machinery, the law (strictly United States interpretations), and "making and losing money." It is copiously illustrated throughout, principally by free-hand sketches. A 1,200 word glossary and comprehensive index complete the book which is designed for the contractor's agent and site engineers.

Symposium on pH Measurement. Presented at the Fifty-Ninth Annual Meeting, American Society for Testing Materials. ASTM Special Technical Publication No. 190. *American Society for Testing Materials*, 1916 *Race-street*, *Philadelphia* 3, *Pennsylvania U.S.A.* (2.50 *dols.*)

During the ten years which have elapsed since the American Society for Testing Materials published a first symposium on pH measurements, significant developments in this field have occurred. Consequently, in order to keep pace with these advances a second symposium was held in June, 1956. The seven papers presented and the discussion thereon have now been made available in printed form. The contents are addressed to process and control engineers as well as to analytical and physical chemists.

On the Shelf

By Frank H. Smith

In view of the interest recently taken in this country (*vide* the correspondence columns) in the desirability of a classical education as a background for technology, it is interesting to note, in a review of *Medical Greek and Latin at a Glance* by Agard and Howe, the sentence "Since no American medical school now requires a knowledge of Latin or Greek of its applicants for admission . . ." It would seem that the dead languages have had a shorter life in the New World than anywhere else!

It may not be generally known that there is an excellent library (with an information service) attached to the American Embassy in Grosvenor Square, London, W.1. There are 30,000 current American books and 500 periodicals and an obliging staff will give every help where things American are concerned. It is now announced that, in addition to normal business hours, the library will in future be open from 12.30 to 4.30 p.m. on Saturdays, except Whitsun and the Saturdays in August.

The latest monthly *Bulletin on Scientific Documentation and Terminology* (UNESCO) is particularly rich in notes on new dictionaries, glossaries, Wörterbücher and what have you. *Wörterbuch für Ingenieurbau und Baumaschinen* is published by Bauverlag G.m.b.H., Wiesbaden, at D.M. 48. It is the German-French, French-German counterpart of the same publisher's German-English, English-German *Dictionary of Civil Engineering and Construction*. Van Nostrand, N.Y. (Macmillan, London), have produced *The International Dictionary of Physics and Electronics* at £6. The authors are W. C. Michels and others. The Union of International Engineering Organisations (49 rue Galilée, Paris 16e) has made available (*gratis*) a 12 page booklet on multilingual technical vocabularies published by its members.

The United States Steel Corporation who have their London Office at 5 Queen-street, E.C.4 have published an attractive 170 page *Design Manual for High-Strength Steels*. Originally published in 1954, a third printing was made in 1956.

That well-known German producer of top-flight text-books, Springer-Verlag, has published *Kurze Produktionsübersicht* up to 1956. This list, which may be obtained from Lange and Springer, Berlin W.35, Reichpietschufer 20, gives all the books which have been published by three different Springer houses during 1956, both in alphabetical order (author and "first operative word of title" in one list) and by subject.

The *Annals of the International Geophysical Year* (Journal of the Central Committee which guides the activities of the I.G.Y.) will be published by Pergamon Press, 4 and 5 Fitzroy-square, W.1, from whom a leaflet giving prices and other particulars may be obtained.

There should be a great demand for the new Science Museum publication *Books on Engineering—a Subject Catalogue of Books in the Science Library*. They are—inevitably—arranged by U.D.C. and the subject index at the end provides a potted version of B.S. 1000A. Although the title of the book implies that there is no author index, this is not so. One follows the subject index. It is an H.M.S.O. publication and at 16*s*. should be within the reach of the most stringently budgeted librarian.

To librarians and bibliographers, changes in the title of journals can be most confusing and irritating. It is noticed that the "Civils" are performing yet another "switch" by killing the *Chartered Civil Engineer* after the July issue and putting a "news and topical articles" section in the Proceedings. The I.C.E. started, I believe way back in 1836 with *Transactions*, then they changed to *Minutes of Proceedings*, then to a *Journal*, then to just *Proceedings* with the separate "gossipy" *Chartered Civil Engineer* and now this has been submerged in the *Proceedings*. Even this collection, though, is easier to sort out than the "Mechanicals" publications.

The habit is spreading, among continental publications, of indexing articles in more than the "home" language. *Strojniski Vestnik*, the organ of the Department of Mechanical Engineering Technical Faculty and of the Institute for Turbomachines, Ljubljana (Slovenia), is indexed and abstracted in the original language and in English, French and German. This system shows at once if an article is worth translating further.

A catalogue that may be regarded as a symbol of the times we live in is that of Nuclear-Chicago. This expensive-looking glossy affair runs to 64 pages and "the line of radiation-measuring instruments presented in this catalog is the most advanced and complete on the market to-day." How far away is the day when new council houses will have a built-in radiation detector? "Get out my lead-lined coat, dear, the radiameter's going up."

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INFORMATION OFFICERS

It is possible that a new professional organisation will be established in the near future to serve the interests of the growing number of information officers. These men and women are playing an increasingly vital part in industry and commerce by their ability to gather information and present it in a form that is acceptable to their colleagues—in management, research, design, production, marketing, etc. Sometimes they are librarians whose functions have been extended, and sometimes they work in parallel with the librarian. They are quite distinct from those people in Press and publicity affairs who are occasionally called information officers.

The proposal to form a new society came up about four years ago. It was taken up by Aslib (Association of Special Libraries and Information Bureaux), who have had extended discussions of the project with the Library Association. At the annual conference of Aslib held at Scarborough last week the suggestion that Aslib should become responsible for some form of qualification, thereby obviating the need for a new society, was rejected by a large majority. It was felt by most delegates that since Aslib members are mostly corporate bodies, such as manufacturing firms, research associations, etc., it would be wrong in principle for part of Aslib's resources to be diverted to such a personal matter as a professional qualification. The way is now open for those information officers who are acutely conscious of their professional status to start a new society. Aslib will continue to provide training courses for information officers and librarians in specialist fields, but they will leave it to someone else to award letters of distinction. A sensible decision.

Further details of the proposed National Lending Library for Science and Technology were given by Miss R. M. Bunn. She said that as the Government had decided that the Library should be located either in the north-west of England or in the West Riding of Yorkshire, and that it should preferably be near a university or a technical college, it was now desirable to select another criterion which would help them to choose the site. It is estimated that the Library will have to hold a million volumes in about 20 years. The D.S.I.R. Lending Library Unit, who are charged with the project, have already made a start with their collection although they are some way off getting the building. They have arranged to receive various publications from Russia which will be available for loan in the United Kingdom later this year. Among the more intractable planning problems is the estimate that in a hundred years time 50 per cent. of the world's scientific and technical literature will be in Chinese (at present the figure is 1 per cent.). The Lending Library Unit will themselves shortly be adding to the world's production of literature by publishing a new periodical, *L.L.U. News*, the first issue of which will appear in June. The Unit welcomes suggestions that will help in the planning of the Library.

About 240 people attended the conference. There were nearly as many women as men. In fact the ratio would appear to be approaching the ratio of marriageable bachelors and spinsters which prevails in Britain at the present time. No great significance, however, should be attached to this statistical accident.

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TRADE PUBLICATIONS

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Railway Electrical Equipment. THE GENERAL ELECTRIC CO. LTD., Magnet House, Kingsway, London, W.C.2. An outline of the range of railway products produced is given in "G.E.C. and the Railways." Traction equipment, including substation plant and control equipment, rolling stock, signalling equipment, commercial lighting, and research topics are included. Illustrated brochure.

Industrial Electronic Equipment. LANCASHIRE DYNAMO ELECTRONIC PRODUCTS LTD., Rugeley, Staffs. General survey of electronic equipment produced. Products include speed and process controls; regulators, and photo-electric, welding and protective equipment. Information is given on other publications that give more detailed descriptions. Illustrated brochure.

Steel Tubes and Bars. TALBOT STEAD TUBE CO. LTD., Green-lane, Walsall. Engineering data on steel tubes, bars, flanges and the like is contained in a pocket book recently issued. Tables given include extracts from British Standards, tolerances, weights, equivalent steels from other countries, and other data.

Movement Control. KETAY LTD., Eddes House, Eastern-avenue West, Romford, Essex. Details of a range of miniature position-indicating and control devices for use in servo-mechanisms. Dimensions and characteristics are given. Illustrated brochure.

"Driver." F. PERKINS, LTD., Peterborough. First number of a quarterly journal intended for members of the Perkins' Drivers Club. Items of technical and general interest.

Degreasing Fluid. NORTON GILES AND CO. LTD., 35 Bessborough-place, London, W.1. "Hilo" degreasing fluid for metal parts, concrete floors and walls. Leaflet.

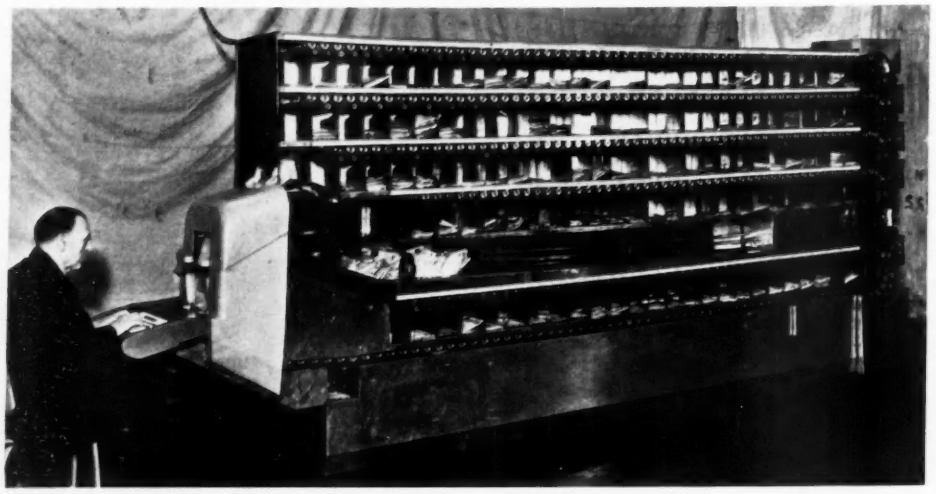

Fig. 1 Letters are sorted at rates that can exceed 3,000 per hour into 120 compartments in a machine developed for the Post Office.

POST OFFICE MECHANISATION

Wherever possible, men are being relieved of drudgery in work, generally by the use of machines and mechanical devices. Not least is this true of the Post Office. Recently at Southampton, machines were demonstrated which eased the sorting of letters, packets and parcels, one of the most time-consuming tasks in a sorting office. One of the great human advantages of the sorting machine that was shown is that it does not drive the operator at any certain pace. He can select his own. This is particularly necessary, of course, when the more abstruse forms of handwriting are encountered. For those which finally defeat even the experienced eye of the sorter, there is an oubliette, the contents of which can be examined at leisure. In action, the unsorted letters (which have previously been "faced"), are presented one at a time to the operator who selects the appropriate pigeon hole by pressing a combination of buttons. The letter is then passed by a delivery system which conveys it to the chosen box. Twenty machines based on this design are being built under contract to the Post Office by the Thrissell Engineering Company, Limited, Bristol. These machines will be installed at offices over the country, with special emphasis at Norwich, where ten will be installed in an experiment to try the effect of mechanically sorting all the post.

LETTER SORTING

The sorting machine for letters is 16 ft. long, 2½ ft. wide and 6 ft. high. Although it weighs some 2¾ tons, being self-contained it can be removed to any position and be in working order again within a few hours. It will handle letters of mixed sizes up to a maximum of 7¼ in. by 5½ in. by $\frac{3}{16}$ in. thick, and is designed to separate them into 120 different pigeon holes. The whole machine is shown in Fig. 1. Basically it consists of four main parts, the letter feed conveyor, the presentation unit, the main conveyor and the selector conveyor system.

The letter feed conveyor is a band which brings the unsorted mail up to the presentation unit, and its action is controlled by a photocell which maintains the first letter in the pile ready to be passed to the presentation unit. The latter takes the letters one at a time by a screw conveyor, and faces them against a window where they are observed by the operator. The unit operates in response to the depression of a pair of keys, and the action is to feed one letter into the main conveyor, present a second to the operator's view, and collect a third from the top of the unsorted stack. An experienced operator can sort 3,000 letters an hour on this machine with comparative ease, as stated before, into any one of the 120 pigeon holes. The hand sorters previously employed by the Post Office sorted letters into racks of 48 pigeon holes at a speed of about 1,300 per hour. To split them up again to final destinations, a second sorting operation was then necessary.

The main conveyor carries all letters from the presentation unit to the start of the selective conveyor system, and includes a synchronising gate which, if necessary, halts the letter for up to half a second in order to bring it into synchronism with the selective conveyor memory system. A feature of the machine is the masking of the machine rhythm from the operator, which allows him to "key" a letter away at any instant. This necessarily means that letters enter the main conveyor at random time with respect to the memory system of the machine, and have to be synchronised before entering the selective conveyor system.

The selective conveyor consists of five horizontal conveyors situated over five rows of stacking boxes, and a vertical distributor feeding these five horizontal conveyors. Diverter blades are interspersed along the conveyors to divert a letter to the correct horizontal run and thence to the correct stacking box. The diverters are operated at the appropriate time by linkages from pin-wheel memories which store the information keyed by the operator until the letter reaches the diversion point.

The drive for the letters on the main conveyor and on the selective conveyor system is by means of pairs of rollers comprising rubber tyred idlers sprung against driven rollers. Every sixth idler is equipped with a centrifugal switch which stops the conveyor should a letter jam in the track.

The control for the machine is partly electronic and partly mechanical. It may conveniently be considered as four units: (i) cold-cathode code storage; (ii) main pin-wheel memory; (iii) thyratron translation field; (iv) diverter pin-wheel memories.

The cold-cathode store is provided to retain the information keyed by the operator until the main pin-wheel memory is in the correct position to permit pins being set. The storage time in the cold-cathode store can be up to half a second, which is the time interval between successive pins on the main pin-wheel memory. The information in the cold-cathode store is transferred to thyratrons which operate pin setting magnets upon being supplied (at the correct time for pin setting) with an anode pulse provided by a switch operated by a cam driven in synchronism with the pin-wheel memory.

The pin-wheel memory, one section of which is shown in Fig. 2, consists of 24 separate pin wheels on a common shaft, each pin-wheel being associated with a particular key on the operator's keyboard. The keyed information is stored in code form whilst the associated letter travels between the presentation unit and the sychronising gate. The letter is then held at the synchronising gate until the pins on the main pin memory which have been set for it operate "reading-off" switches. The letter is held at the sychronising gate for a maximum of half a second, the waiting period at the gate for any particular letter being equal to the time that the coded information was held in the cold-cathode store.

In addition to controlling the sychronising gate, the "reading-off" switches also operate into the thyratron translation field which consists of a 12 by 12 matrix of thyratrons. Thyratrons with two grids are used, and each has one grid in a column and one grid in a row. The left-hand part of the key combination acts on the grids in a row, and the right-hand part on the grids in a column. By this means, for any given two-key combination, only the thyratron at the crossing point of the row and column associated with the two keys is fired. This performs the translation from code form to an individual selection.

In the anode circuit of each thyratron is a pin-setting electro-magnet associated with a stacking box diverter pin-wheel, and a pin-setting electro-magnet associated with the appropriate "level diverter" (the diverter which routes the letter to the required horizontal conveyor) pin-wheel.

Thus the letter is released from the sychronising gate at the same time as a pin is set on the appropriate level diverter pin-wheel memory

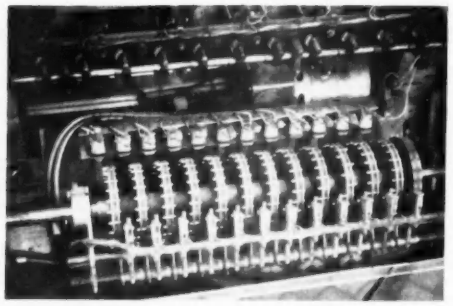

Fig. 2 Pin wheels act as both main and diverter memories for routing the letters to the selected boxes.

and on the stacking box pin-wheel memory. From this time the letter travels in synchronism with the pin-wheels so that as it approaches the level diverter and the box diverter these are operated mechanically by the pins which have been set to route the letter, firstly on to the correct horizontal level and then into the correct stacking box. The pin-wheels associated with the stacking boxes have too small a storage capacity to "mark" a letter from the sychronising gate to the most distant stacking box and it is necessary for the setting of pins on the more distant stacking box pin-wheel to be delayed until the letter has progressed some distance from the synchronising gate. In order to provide this delay, a second bank of "reading-off" switches is provided on the main pin-wheel memory which operates (about five seconds after the first set of reading-off switches) into a second 12 by 12 matrix of thyratrons. These thyratrons operate pin-setting magnets to set pins on the memory wheels associated with the more distant stacking boxes.

Although basically the control system of the machine is capable of sorting to 144 different selections, only 120 selections are used in this application. However, 133 stacking boxes are provided, the surplus boxes being used to supplement the capacity of boxes associated with destinations for which there are heavy postings. A system of uni-selectors is used to control the distribution of letters between boxes associated with the same destination.

In addition to the 24 "code" keys on the

operator's keyboard, a "feed" key and a "cancel" key are also provided. The feed key is thumb operated and causes the presentation unit to perform one cycle of operation, feeding a letter into the conveyor system and routing it to a permanently open "overflow" box at the end of the top horizontal conveyor. This facility prevents the operator from being delayed by having to remove by hand any letter which he is unable to sort (e.g., incorrectly addressed letters or letters which arrive in the viewing window reversed or upside down). The "cancel" key is provided to enable the operator to cancel his previous keying operation to divert a letter to a separate box should he realise that he has keyed incorrectly.

Two vertically disposed viewing windows are provided, a letter falling from the upper to the lower at each keying operation. An experienced operator reads the address of the letter in the upper viewing window whilst he keys the combination appropriate to the letter in the lower viewing window. By this arrangement keying speeds can be increased by a substantial margin compared with a system where the operator is required to read an address and operate the appropriate keys for that address in one operational cycle.

A switch is provided on the machine to change the relationship between the key combinations and the position of the stacking boxes for the sorted mail, so that the machine may be used for sorting to delivery areas within the town ("inward sorting") or for sorting mail to places outside the town delivery area ("outward sorting"). By this means it is possible to group the stacking boxes in the most convenient order for clearing, and at the same time to arrange for the boxes which have the heaviest postings to be associated with the most easily operated key combinations. The code for the operating keys has been chosen in accordance with the initial letters of the significant address.

PARCELS AND PACKETS

For dividing mixed mail into parcels and packets, the Post Office engineers have produced the machine shown in Fig. 3. The mixed mail is tipped into a loading hopper and carried by a belt into the segregating drum. This rotates slowly, and the flaps which form the inner surface swing open under gravity, and allow the thin letters to pass through on to a belt that runs below. Newspapers, packets and bulky letters, that is, more than $\frac{3}{16}$ in. in thickness, are retained within the drum and slowly roll down it on to the sorting and stamping table at the end. The passage is slow, and the operation does not damage the parcels involved.

The thin letters that have been filtered out through the drum are taken by the conveyor belt below, to two tower units, one at each side, one of which can be seen in detail in Fig. 4. These contain a vertical series of spring rollers, separated by 8 in. gaps. "Short" letters slip out between the gaps, and slide down the outside on to a collecting device, but "long" letters bridge the gaps and are carried to the top of the towers whence they are delivered to another set of belts. The separate streams of short and long letters are carried on to their respective points for facing the right way up and post marking. This separation is necessary to suit the mechanical stamping machine and the sorting machine just described. At present, all this task of separation has to be done by hand, and the drum segregator and its separator towers are still in the experimental stage. It is planned to add a device which will take the letters from the separator towers and "face" them automatically, each with its stamp in the same corner, to avoid the last stage of manual work.

PACKET STAMPING

A problem that has faced the Southampton Post Office for some years has been the mass of magazines coming over from America in enormous quantities with each boat. After the arrival of any of the large ships, several members of the Post Office staff had to spend their entire time stamping the separate magazines for transhipment. This was both time and labour consuming. A device has been produced by the engineers very reasonably and simply, consisting of a broad conveyor belt which will take two rows of magazines at a time and runs them under two rotary stamping heads. At the far end are placed mail bags, in which the magazines fall. Although so simple in design and execution, the machine has proved a great economic asset to the office. In another of the sorting offices in Southampton, an overhead chain conveyor has been installed for handling bags of parcels. The bags are gripped by their bottoms, so that when the string constraining the neck is cut, the parcels will fall out on to the sorting table.

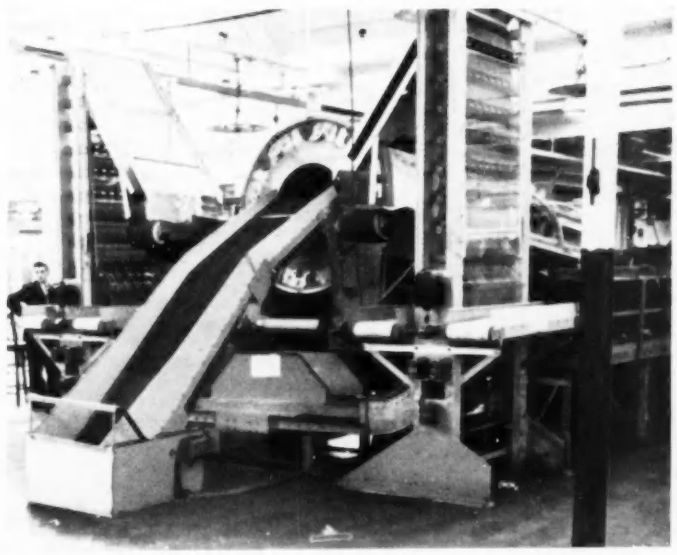

Fig. 3 Mail is divided into letters and parcels by a rotating drum with swinging flaps. Letters are subsequently divided into "long" and "short" by the two towers.

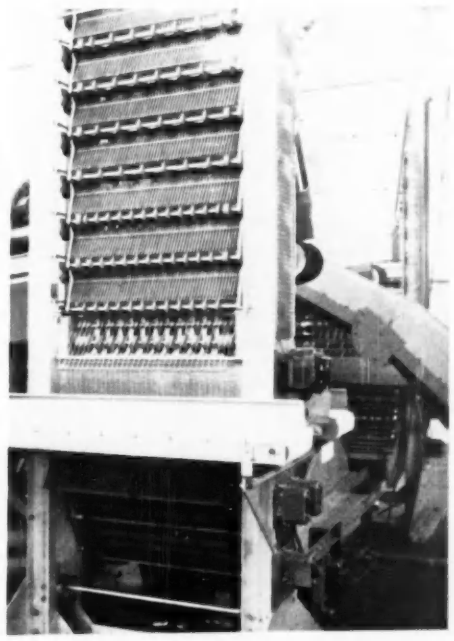

Fig. 4 "Short" letters fall between the rollers in the vertical towers, but "long" ones are carried to the top to a second conveyor belt.

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FILTER SEPARATOR

Fuel oils and many other liquids tend to absorb a certain amount of water and dust during storage which is harmful to their subsequent use. Various types of filter and dehydrator have been introduced for clearing them of unwanted matter. A sample of one of the most recent filter separators made by Bowser International Limited, Kent House, Market-place, Oxford-circus, London, W.1, was exhibited at the recent Factory Equipment Exhibition on the stand of Liquid Systems, Limited, Union-road, Croydon, Surrey.

Two standard sizes are made, one of which is capable of dealing with 250 Imperial gallons per minute, and the other with twice this amount. One of the main advantages claimed for these units is that they can be fitted in the straight run of piping, as both inlet and outlet are at the bottom and directly opposite each other. The filter elements used consist of two stages of pre-densified Fibreglass, the first of which has larger apertures between the fibres, which in the second are reduced to between 2 and 4 microns. The coarser element removes the majority of the suspended matter, and in the finer, the minute water droplets are coalesced by compression into larger drops which, when they have passed through the filter, separate out from the oil. A cloth cartridge wraps the element and causes the water drops to be retained, and a second cloth outer sleeve ensures that any that pass through the first are not carried mechanically by the rush of liquid into the clean oil.

The water collects at the bottom of the vessel and can be withdrawn by a hand-operated valve used at required intervals (there is a sight-glass on the side to show the level of water accumulated), or fully or semi-automatic systems can be fitted. In the latter an interface float operates magnetically, opening the drain valve; should the quantity of water still increase, it can be made to stop the oil flow. Alternatively, an alarm can be sounded when the water rises to a pre-determined level.

In the smaller model there are 12 filter elements, and in the larger 24. Each can be removed separately, after the cover of the whole vessel has been lifted. To ease the latter process, a lifting handle has been fitted which, when the clamping bolts have been freed, lifts the cover with a toggle action, and then forms a pivot to swing it clear of the casing. In this way, no heavy maintenance equipment is required.

The diameter of the shell of the larger model is $40\frac{3}{4}$ in. and its overall height $83\frac{1}{4}$ in. The minimum height required to remove the elements is only 88 in. The pressure drop across the filter is low, only of the order of about 1 lb. per sq. in., and can be indicated either by two separate gauges or by a single gauge with two stop valves. Normal working pressure is 150 lb. per sq. in. Horizontal units will be available shortly.

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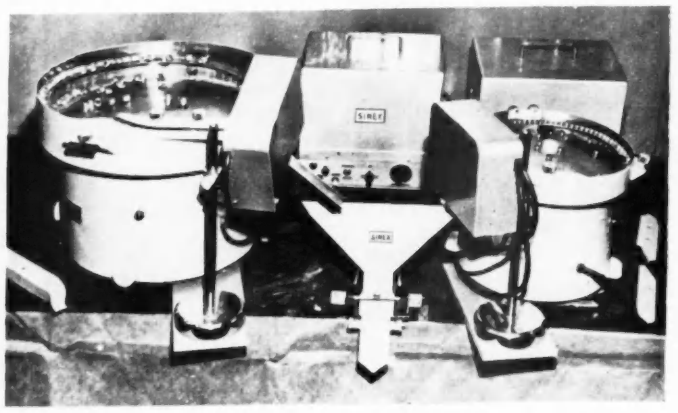
Designed from the start as a jet trainer aircraft, the M.100 Student, constructed by F. G. Miles, Limited, Shoreham Airport, Sussex, flew for the first time on May 14.

It is to be made available in both single and twin-engined versions with modern flying characteristics, and care has been taken in the design to ensure that countries without a highly developed aircraft industry would be able to undertake construction themselves. A Marboré jet engine develops 880 lb. static thrust, and the maximum speed is over 300 m.p.h.

COUNTING A MIXED BATCH

For the express purpose of making up batches containing specific numbers of two different components, the Sinex Engineering Company, Limited, 12 Rochester-row, London, S.W.1, have produced the machine shown in the illustration. It has two vertical vibrating bowl feeders, two batch-counting units, and two photo-electric detector heads; it is capable of expansion to use more feeders according to the number of different articles required for the batch. For the specific application described, it was required to batch pipe unions and olives in sets of from 1 to 10 of each into Polythene bags. The bowls also had to be adaptable to accommodate three sizes of each of the articles concerned. In operation, the left-hand bowl is filled with unions and the right-hand with olives. The bowls are then adjusted to suit the size of the part in use. The counters of each are set to the required number, in this case ten, and the operator places a Polythene bag in position at the mouth of the shute. The machine then proceeds to count the batch through the photo-electric detectors and delivers the articles to the collecting funnel; after the chosen number has been passed, it will stop. The operator then pulls the lever on the funnel, so opening the gate and releasing the batch into the bag. Replacing the lever in the closed position automatically starts the feeders, re-sets the batch counters, and commences the delivery to the funnel of the second batch. It is only a matter, therefore, of operating the lever each time the bag is in position to obtain almost continuous operation of the machine. Interlocking controls prevent the gate opening if for any reason a batch is not complete. The counting period is normally less than the time taken by the operator in removing the full container and replacing it with an empty one, and in the example given above the speed of the operator would restrict the number of batches handled to about 30 per minute. It would be quite feasible to actuate the machine within a conveyor system which would automatically position boxes below the mouth of the funnel so that completely automatic operation could be obtained.



Two or more items can be batched together in any required number by this machine as, for example, pipe unions and olives.

5,000 MVA 132 KV OIL CIRCUIT-BREAKER

A Basic Design Up-rated

The increase in the demand on the 132 kV national grid has necessitated the progressive uprating of many of the circuit-breakers installed, work which frequently necessitates the removal of the units to the manufacturer's works and careful planning to avoid undue interruption of supply. It is therefore of interest to learn that the General Electric Company, Limited, Kingsway, London, W.C.2, have introduced a new three-phase oil circuit-breaker with a breaking capacity of 5,000 MVA at 132 kV and a current rating of 1,600 amperes, which enables the 2,500 MVA and 3,500 MVA units in this range to be uprated on site by carrying out relatively simple alterations and replacements, thus involving the minimum of outage time. This development has been obtained solely by modifying the main contacts and arc control pots.

The new circuit-breaker consists of three separate single-phase units, which are linked externally to a common operating mechanism and are enclosed in cylindrical steel tanks. The oil-filled condenser type terminal bushings pass through conical sockets in the top dome to permit small angular adjustment, and the ring-type current transformers are threaded over them in a chamber forming part of the oil-tight and moisture-proof outer shell.

The arc-control pots are of the General Electric side-blast pattern, equal voltage distribution between the two breaks in each phase being ensured by non-inductive switching resistors. These resistors are mounted near the control pots and are connected during the arcing period between the fixed and moving contacts. The fixed contact assemblies comprise six easily replaceable self-aligning fingers and an arcing contact. They are arranged to give circular line contact with the renewable copper tips which are fitted to the moving-contact stems. The arcing contacts inside the control pots are designed to carry the full-load current and the moving copper contact is tipped with arc-resisting heavy alloys.

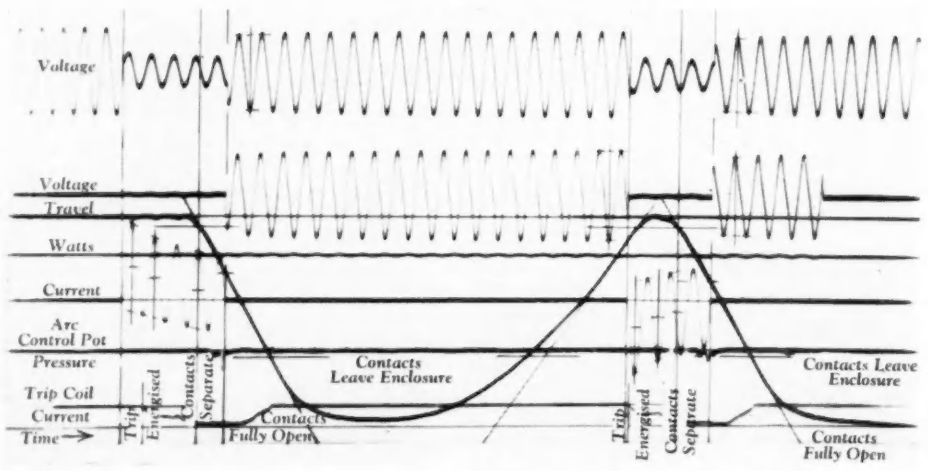
The moving contacts are raised by a rod of laminated wood, thoroughly impregnated with synthetic resin and the lower end of which slides in guides of the same material. The upper end of this rod is connected through a system of duralumin levers to a horizontal pull rod which is actuated by the operating mechanism. The circuit-breaker is opened by torsion-bar springs, which are fitted inside torsion tubes to form a compact unit. Owing to the low inertia of this type of spring and of the moving-contact assembly acceleration of the contacts is rapid and a total short-circuit break type of three cycles is obtainable.

The closing mechanism, which is trip-free in any position, is designed for either solenoid or pneumatic operation. When a solenoid is used the closing delay is reduced by employing a laminated construction for the magnetic yoke and armature. The solenoid circuit is automatically opened when the circuit-breaker is closed so that the battery consumption only amounts to 7 kilowatt-seconds for each operation. In the pneumatically operated units the normal air pressure is 150 lb. per sq. in. and interlocks prevent operation if it falls below the minimum safe value.

Normally the mechanism is designed for three-phase high-speed re-closing, but single-phase reclosing can also be provided. In both cases all three phases are closed simultaneously, while three-phase tripping is also synchronised by means of a common trip coil.

One of the new circuit-breakers has been subjected to a comprehensive series of tests in the company's High Power Testing Laboratory at Witton to prove its performance in excess of 5,000 MVA. As a result an A.S.T.A. certificate has been issued confirming the rating.

In addition to tests which were carried out in accordance with British Standard Specification No. 116 of 1952 and of the Association of Switchgear Testing Authorities No. 15, others were made by switching two systems which were out of synchronism, breaking small highly-inductive currents, switching unloaded transmission lines and high-speed reclosing. An oscillogram of one of these high-speed reclosing tests is reproduced on this page. In the breaking tests the moment of contact separation was controlled in relation to the current wave and was adjusted for each operation to ensure that the tests were made to cover all the conditions likely to occur in service. The tests were carried out with both solenoid-operated and pneumatically-operated circuit-breakers and were of a realistic character since the company's laboratory is connected to a section of the 132 kV grid.



An oscillogram of a high-speed reclosing test which was carried out on the new General Electric 5,000 MVA 132 kV outdoor oil circuit-breaker.

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TRAINING IN AERONAUTICAL ENGINEERING

Educational grants are made by the Society of British Aircraft Constructors, and administered by the Royal Aeronautical Society, for the purpose of assisting young men who are unable, for financial reasons, to obtain training in aeronautical engineering. Applicants should be between the ages of 16 and 18 years on September 1 in the year of the award. All holders of these grants are expected to qualify for a technical grade in the Royal Aeronautical Society, the address of which is 4 Hamilton-place, London, W.1.

ATOMIC REVIEW

Random Distribution

EVENTS viewed over a period may exhibit a general trend, but at any one time a pattern is difficult to discern. It follows that a weekly survey of current news must occasionally, at least, assume a somewhat random character.

Japanese Purchase

In spite of American efforts (see Plain Words last week), it now seems certain that Japan will purchase a Calder Hall type of reactor. A recent report states that the nine principal Japanese electric power companies are jointly to purchase two power reactors, one of British and the other of American design. An atomic power generation company with a capital of £50 million is to be set up for this purpose, and will purchase from Britain a gas-cooled graphite-moderated reactor of 140 MW electrical output. A discussion of Japanese atomic energy plans was published in Atomic Review last January 4.

Bradwell Station

Rapid progress is being made on the first two nuclear power stations for the Central Electricity Authority at Bradwell and Berkeley. Referring recently to the station being built at Bradwell, Essex, by the Nuclear Power Plant Company, Limited, Sir Claude Gibb said that each reactor would be contained in a spherical vessel 66 ft. 9 in. in diameter made of a special steel 3 in. thick. The thickness would be increased to 4 in. at the crown, where access for fuel elements and control rods would be provided.

The graphite core would weigh about 2,000 tons and would contain some 2,640 channels for the fuel elements, which would be rods of initially pure uranium metal 1 in. in diameter encased in finned magnesium cans. The gas ducts for the carbon dioxide coolant would be 5 ft. in diameter and the gas temperature at the reactor inlet would be 365 deg. F. and at outlet 800 deg. F. There was a small diameter duct with valves, the function of which was to enable one heat exchanger with its circulator to be taken out of service without shutting down the reactor and without more than a 5 per cent. reduction in the electrical output. All the gas circulators were of variable speed and if one of the six was taken out of service the speed, and therefore the mass flow of gas, from the other five could be increased and very nearly the same amount of heat extracted from the reactor core.

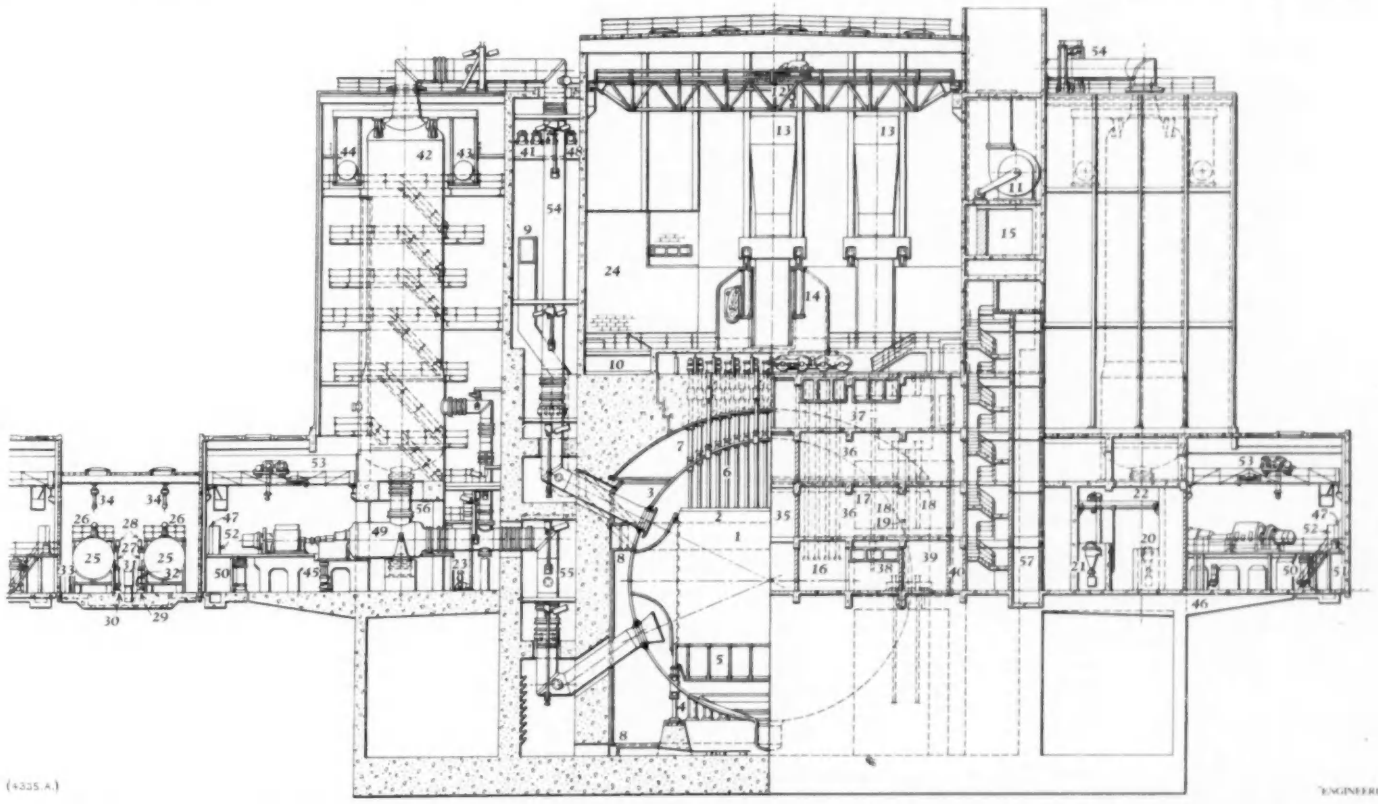
Figs. 1 and 2 show the arrangement of one reactor, its six associated heat exchangers, gas-circulation plant, and fuel charge and discharge machines, one used as standby. Charging and discharging would, Sir Claude said, be carried out on load. A charge-discharge machine would be lowered on to one of the concealed access pipes and a joint made. The pressure inside the charge machine would then be raised to that within the reactor vessel (150 lb. per sq. in.), and once the two pressures had been equalised a communicating valve would be opened. A grab would be lowered into the access pipe: first to withdraw a concrete shielding block, which would be placed temporarily in a compartment in the machine, and then to extract and replace the spent fuel element, which would be stored in a shielded magazine. After replacing the shielding block and closing the communicating valve, the machine would be again de-pressurised. At Calder Hall, where charging and discharging cannot be carried out on load, separate machines are required for the two operations. Sir Claude, who is chairman of C. A. Parsons and Company, Limited, a member of the N.P.P.C. group, was speaking at a conference during the recent Instruments, Electronics and Automation Exhibition. A description of the Bradwell station appeared in Atomic Review last February 22.

Berkeley Station

Work on the station at Berkeley in Gloucestershire being built by the A.E.I.—John Thompson Nuclear Energy Company, Limited, has reached an advanced stage. Last month it was reported that one of the station's fuel-charging machines was well on the way to completion at the works of John Thompson, Limited, and Fig. 3 shows sections of the bottom dome for one of the 1,000 ton 3 in. thick reactor vessels fitted together on a jig before transfer to the site. The vessels will be 50 ft. in diameter and 80 ft. high and mounted on rockers to allow for expansion. Heat exchangers and thermal shielding are also taking shape.

Purchase of Uranium

The United Kingdom Atomic Energy Authority have published an offer to purchase uranium-



(4335.A.) "ENGINEERING"

Fig. 1 Arrangement of one reactor, gas circulating plant, heat exchangers and fuel charge and discharge machines for the Bradwell nuclear power station.

1. Graphite core
2. Charge pans
3. Reactor shell
4. Reactor supports
5. Reactor diagrid
6. Reactor charge standpipes
7. Reactor control standpipes
8. Reactor ventilation suction ring mains
9. Reactor ventilation fan suction duct
10. Reactor ventilation inlet ducts
11. Reactor ventilation fans
12. Reactor hall crane (15 ton)
13. Charge-discharge machine (main and standby)
14. Charge-discharge machine gantry
15. Reactor ventilation fans
16. Charge-plug stowage holes
17. Charge-plug preparation tube
18. Control-rod maintenance tubes
19. Chain disposal tube
20. Carbon dioxide dryer filters
21. Main carbon dioxide by-pass filters
22. Filter room crane (2 ton)
23. F.P.D. reciprocating compressor
24. Charge control block
25. Carbon dioxide storage tanks
26. Carbon dioxide storage tank condenser
27. Carbon dioxide evaporators
28. Carbon dioxide liquid-vapour separators
29. Liquid carbon dioxide transfer pumps
30. Carbon monoxide and carbon dioxide vacuum pumps
31. Electrode boiler
32. Electrode boiler feed tank
33. Process control panel
34. Carbon dioxide equipment lifting beam and hoist (1 ton)
35. Hoist well
36. Fuel storage rooms
37. Fuel preparation room
38. Charge-plug preparation room
39. Calorifier and pump chamber
40. Pipe duct
41. Reactor carbon dioxide relief valves and filters
42. Boilers or heat exchangers
43. Boiler high-pressure steam drums
44. Boiler low-pressure steam drums
45. Boiler high-pressure C.W. pumps
46. Boiler low-pressure C.W. pumps
47. C.W. boards (boiler C.W. pumps)
48. Boiler carbon dioxide relief valves and filters
49. Main circulator
50. Main circulator lubricant and seal oil coolers
51. Main circulator oil purifier
52. Main circulator and boiler instrument panels
53. Circulator hall crane (10 ton)
54. Main carbon dioxide ducts reactor to boiler
55. Main carbon dioxide ducts circulator to reactor
56. Main carbon dioxide ducts boiler to circulator
57. Lift shafts

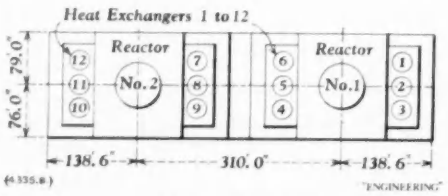


Fig. 2 Layout of reactors 1 and 2 and heat exchangers 1 to 12 for the Bradwell station being built by the Nuclear Power Plant Company.

bearing ores from small producers in the Federation of Rhodesia and Nyasaland. Until March 31, 1964, the Authority is prepared to purchase, in any one year, suitable ores containing up to 100 tons of uranium oxide, and will accept small consignments containing not less than a quarter ton of oxide. The price paid for material accepted will vary according to the grade of ore. For example, for each lb. of uranium oxide contained in the ore the price will be 30*s*. where the grade is 0·2 per cent. which is the minimum grade acceptable, 35*s*. where it is 0·5 per cent. and 40*s*. where it is 5 per cent. or over. To encourage the development of new sources of uranium, a special price of 55*s*. per lb. will be paid until March 31, 1962, for the first 5 tons of uranium oxide contained in acceptable ore delivered from each completely new mine. Payment will be made after the ore has been delivered to and assayed by the Authority's agents, and the Authority will make a substantial refund of rail charges. Copies of the Authority's formal offer which contains full details of prices and of the terms of purchase can be obtained from the Officer-in-Charge, U.K.A.E.A. Office, P.O. Box 8009, Causeway, Salisbury (Telephone: Salisbury 22398). Information and advice may be obtained in the United Kingdom from the Metals Branch, U.K.A.E.A., St. Giles Court, 1-13 St. Giles High-street, London, W.C.2. This offer is directed primarily to the small prospector and miner. The Authority will be pleased to consider separately the purchase of uranium from larger deposits.

Stockpiling Bismuth Metal

Among the adjournment debates, which have taken place in the House of Commons recently was one on a suggestion for the accumulation of stores of bismuth metal against a possible future demand by the United Kingdom Atomic Energy Authority. The matter was raised by Mr. Ronald Russell (Conservative), who stated that a firm in his constituency, Mining and Chemical Products, Limited, Alperton, which supplied bismuth metal to the Authority, had been asked about the possibility of increasing the supply. It would not be easy to increase the supply quickly because the metal, which was obtained as a by-product in the extraction of other metals, chiefly lead, from their ores, came from such countries as Bolivia, Mexico and Korea. A sudden increase in demand would probably result in a substantial rise in price.

The plan was to lay in stocks gradually, from now on; a proportion of the price to be paid by the Government department concerned. If, eventually, it were found that the stocks were not needed, the firm would take them back at the same price and at the same rate at which they were accumulated. The firm would take the risk of any loss in the handling of the metal.

In reply, Mr. F. J. Erroll, the Parliamentary Secretary to the Board of Trade, said that, for some time past, the Authority had been investigating the possibility of using what were called liquid-metal fuel reactor systems. In this connection, it was decided that a small quantity of bismuth metal, about 20 tons, should be bought for use in the basic experiments. While these experiments were going on, the Authority considered what might happen if the initial work were successful and an experimental reactor were built, and, if the reactor were successful and it was decided to go into large-scale production. The firm were, he understood, the main importers of bismuth into the United Kingdom and it was quite appropriate for the company to suggest that a stock of bismuth metal should be built up on behalf ot the Authority. The possible future for this type of reactor had been investigated by the Authority and, as a result of that review, the Authority had informed the company that it had at present no requirement for bismuth other than for the small order which had already been placed.

The liquid-metal fuel reactor systems were still in an early stage of study—not even of development. There were many competing forms of reactor awaiting development, and it must remain unknown for some time whether that type would be chosen for future large-scale production. There would have to be a great deal more work done before any large-scale requirements for bismuth could possibly emerge. The development of new ideas in atomic energy often raised at an early stage the possibility of demands on a large scale for substances which were at present required in world markets only in very limited quantities. It was obvious that the Authority could not undertake to stockpile all those materials against the possibility that they might eventually be required.

Reactor Technology for Executives

The next reactor technology courses specially arranged for senior technical executives will be held at the Reactor School, Atomic Energy Research Establishment, Harwell, from October 21 to 31, 1957, and from January 6 to 16, 1958. These will be the first such courses for senior executives open to overseas as well as British students. The courses are planned to give to senior industrialists with a technical background, an overall appreciation of the problems of reactor technology. The lectures will cover the physical, metallurgical and engineering problems involved in the design of power reactors and the chemical problems of fuel and effluent processing. There will also be lectures on the United Kingdom's Nuclear Power Programme and on the organisation of the United Kingdom Atomic Energy Authority and its relations with industry. Informal detailed discussion of particular points will be encouraged. There will be visits to laboratories and reactors within the Establishment. The fee for a course is £50 (excluding accommodation). Selection of the students will be made three months before the start of each course. Requests for information about these and other reactor technology courses should be addressed to the Reactor School.

Electronics Course

The twelfth specialised course on the design, use and maintenance of electronic instruments used in nuclear physics, radio-chemistry and in work with radioactive isotopes will be held in the Reactor School, Atomic Energy Research Establishment, Harwell, from July 15 to 19. The course will include lectures, demonstrations, and practical work on many types of electronic instruments including counters, D.C. and pulse amplifiers, scalers and rate meters. The course is intended primarily for physicists and electronic engineers; the course fee is 25 guineas, which does not include the cost of accommodation in the district, but local accommodation can be arranged on request. Since the number of places on the course is limited, application forms should be returned as soon as possible, and in any case before June 21. Application forms and further information may be obtained from the Divisional Administration Officer, Electronics Division, A.E.R.E., Harwell, near Didcot, Berkshire.

Nuclear Engineering Courses

The syllabus for a week's residential course on nuclear engineering to be held at Hugh Stewart Hall, University of Nottingham, from September 16 to 20, 1957, is now ready. The chairman of the organising committee is Mr. B. L. Goodlet and subjects to be covered range from reactor physics, heat transfer and metallurgy to fuel cycles, fuel processing and discussion of particular reactor systems. Application should be made to the Hon. Secretary, Nuclear Engineering Course, Departments of Civil and Mechanical Engineering, The University of Nottingham, University Park, Nottingham.

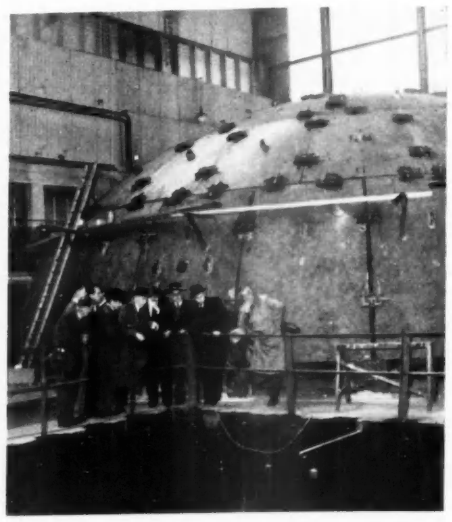


Fig. 3 Part of a reactor pressure vessel for the Berkeley nuclear power station being built by the A.E.I.—John Thompson Nuclear Energy Company.

The Massachusetts Institute of Technology are to offer a two-week programme in nuclear reactor technology from June 24 to July 5, 1957.

Appointments

It has been reported that Colonel George W. Raby, Deputy Director (Engineering) at the Atomic Energy Research Establishment, is leaving on July 1 to join Atomic Power Constructions, Limited, as managing director. A.P.C. is the fifth large British group in the nuclear power field and includes Richardsons Westgarth and Company, Limited, Crompton Parkinson Limited and International Combustion (Holdings), Limited, associated with Trollope and Colls, Limited, and Holland and Hannen and Cubitts, Limited. Reference to the group was made in Atomic Review last November 16, December 28 and January 18. Colonel Raby has previously served with Richardsons Westgarth, and the English Electric Company.

Mr. J. R. V. Dolphin, C.B.E., who has been Chief Engineer to the Weapons Group of the United Kingdom Atomic Energy Authority since 1951, has been appointed Chief Engineer to the Authority's Research Group. He will take up his new duties at Harwell on August 1, 1957. Before the war Mr. Dolphin was a consultant on the planning of power stations.

The United Kingdom Atomic Energy Authority have appointed Mr. F. R. Farmer to the post of Chief Safety Officer to take charge of the newly formed Safety Branch.

Dr. P. Fortescue, well known for his work at Harwell on gas-cooled reactors and in particular on the concept of the VHT (very high temperature) system, is soon to be granted two years extended leave by the Atomic Energy Research Establishment in order to take up an appointment in the United States as research and development manager of General Atomic Incorporated, San Diego, a subsidiary of the General Dynamics Corporation.

Radiation Precautions

A booklet, *X- and Gamma-Ray Safety Precautions*, has recently been published by the British Welding Research Association, 29 Park-crescent, London, W.1. The aim of the booklet is to provide, clearly and simply, information on the hazards which may be encountered and the precautions to be taken by those using radioactive sources. The following subjects are discussed: radiation hazards, maximum permissible dose, precautions (with examples), and the manipulation of radioactive isotopes. The price of the booklet, which may be obtained from the Association's offices, is 2*s*.

ROAD CONSTRUCTION IN LANCASHIRE

Progress on the Preston and Longton By-Passes

Lancashire boasts what is probably the most ambitious road programme actually in hand in the United Kingdom—the Longton by-pass and the Preston by-pass, the latter being the first motorway to be constructed in the country. The former is on the Liverpool-Preston-Leeds trunk road, A.59, four miles west of Preston and is 2·56 miles long, by-passing some 3 miles of existing narrow and tortuous roads through the straggling village of Longton. The new dual 26 ft. reinforced-concrete roadways are due to be completed by October, 1957. The Preston by-pass is 8¼ miles long and will have dual three-lane carriageways of flexible construction throughout its length; apart from the junctions at the extremities, there is to be only one road connection along its length (at Samlesbury). To preserve this limited access, the new by-pass will be taken over or under all existing roads, footpaths, railways, rivers and streams met on its route. In addition, owing to land severance, occupation bridges have to be provided over or under the motorway. As a result, 23 new bridges will be required, as well as some very substantial cuttings and embankments made, for the new by-pass.

Last week we joined a party organised by the Pavings Development Group (Concrete and Soil Cement), sponsored by the Cement and Concrete Association, which visited the sites to see the progress being made. It will be appreciated that the speed and success with which these two Lancashire roads are completed will have considerable bearing on the speed with which the Government will implement a national road programme.

LAYOUT AND DESIGN

The layout of the Longton by-pass provides dual carriageways 24 ft. wide with a central reservation varying in width from 10 ft. at the south end to a nominal width of 26 ft. at the north end, widening at one point to 40 ft. to avoid excessive tree felling. One bridge, with a skew span of 32 ft. 4½ in., is required to carry the motorway over the Preston-Southport railway.

The central reservation is also widened to 26 ft. at two junctions with Class III roads and one junction with an unclassified road. As two of these junctions occur at the north end, in a length on which the Preston by-pass will eventually commence, the 26 ft. width is maintained between the two junctions. At these junctions acceleration and deceleration lanes, marked by a coloured surface, are also provided. At two other junctions with unclassified roads which carry very light traffic, no widening of the central reservation or carriageways is provided.

Curvature of the by-pass varies from a radius of 3,183 ft. to 40,000 ft. and the design speed is 60 m.p.h. Gradients vary from 1 in 250 to 1 in 30, the latter being on the approaches to the bridge which carries the by-pass over the Preston to Southport railway.

The land covered by the by-pass is flat in character, and consequently no deep excavation could be undertaken because of the difficulty of finding drainage outfalls; a balance of cut and fill was therefore found to be impossible. Excavated material, boulder clay, is used in filling under verges and footways; for filling under carriageways burnt colliery shale is imported and compacted to a dry density of 100 lb. per cub. ft.

The soil survey indicated that the California Bearing Ratio of the clay varied from 2·4 to 9·6; in general the clay is suitable for filling or for bearing in the cuttings. On the formation level in excavation the clay is covered with shale varying in depth from 6 in. to 10 in. In some isolated cases soft material is dug out and replaced by shale underneath the carriageways.

The shale is surface dressed with hot tar at the rate of 4 sq. yards per gallon and ½ in. limestone chippings at the rate of 100 sq. yards per ton. This procedure seals the shale and gives strength to carry the construction traffic until the concrete carriageway is laid.

Two box culverts and several pipe culverts have been provided, and surface water and subsoil drainage is generally discharged into these culverts. A drain is provided for each carriageway and surface water is drawn off into gullies.

CONCRETE CARRIAGEWAYS

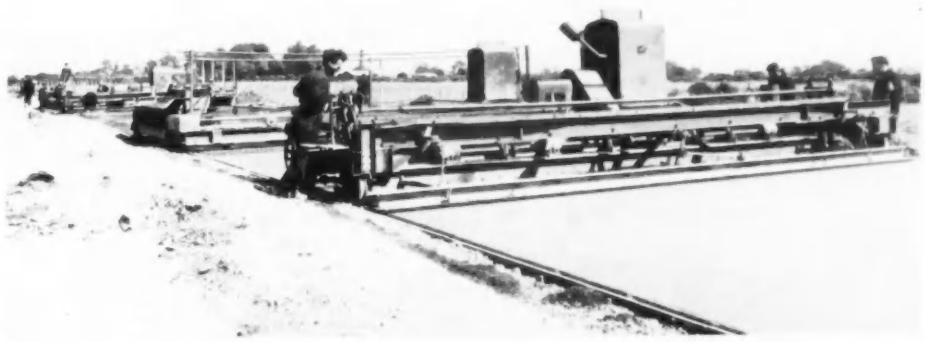
The carriageways are of 10 in. reinforced concrete of a minimum specified compressive strength of 4,000 lb. per sq. in. at 28 days, machine laid to a width of 26 ft. and constructed on a 1 in. bed of sand compacted on the surface-dressed shale. The concrete slabs are 2 ft. wider than the carriageways to allow 7 in. by 4 in. splayed concrete kerbs to be laid on the slabs. The kerbs are backed with concrete which is dowelled to the slabs with ½ in. bars, 5 in. long, placed at 15 in. centres. The bars are hammered into the slabs immediately after compaction.

The concrete is laid in two layers 7½ in. and 2½ in. thick, the top layer being compacted within one hour of laying the bottom layer. The coarse aggregate used in the bottom layer is 1½ in. to ⅜ in. limestone, which is delivered to the site in two sizes, namely 1½ in. to ¾ in. and ¾ in. to ⅜ in.; in the top layer the aggregate is ¾ in. to ⅜ in. granite. The fine aggregate in both layers is washed pit sand. At irregular areas such as roundabouts, lay-bys, etc., the concrete is compacted using hand-guided beam vibrators. The aggregate: cement ratio varies from 7·5 to 5·25 according to whether the aggregate is limestone or granite, the concrete is machine or hand laid or air entrainment is used; for the same reasons the total water: cement ratio varies from 0·55 to 0·47. The compacting factor of the concrete is 0·82 for machine work and 0·85 for hand work.

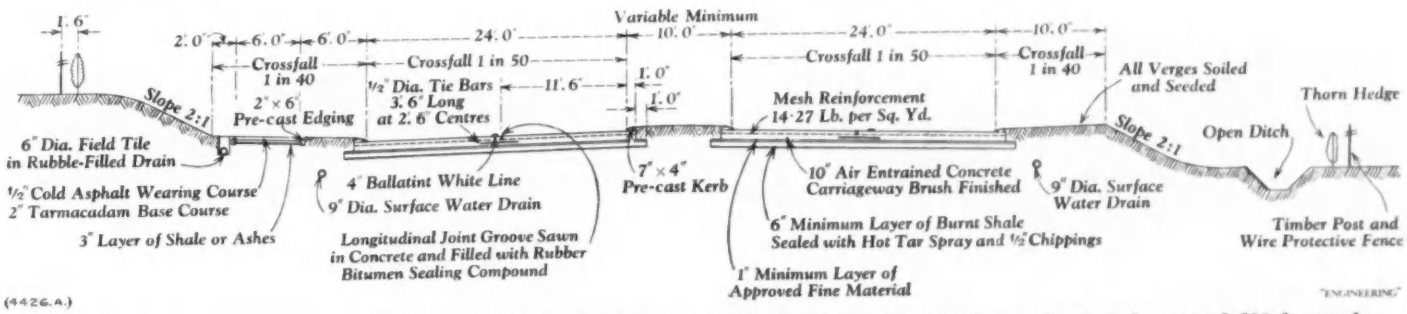
The concrete is mixed at a central batching and mixing plant which has a 2 cub. yd. capacity mixer, and is transported to the site in tipping lorries. Moisture contents of all aggregates are checked twice daily, and the compacting factor test is frequently carried out. The sand layer is placed and compacted by machines operating from rails subsequently used for concreting. Each of the two layers of concrete is laid by a separate train of plant, consisting of one spreading and one finishing machine. The surface of the concrete is brush finished, and on the lay-bys and acceleration and deceleration lanes the concrete is tinted by means of a coloured cement.

One carriageway is singly reinforced with 14·27 lb. per sq. yd. of fabric, placed on top of the compacted bottom layer. The concrete in both courses is air-entrained to give a total air content of about 4½ per cent. by volume. One half length of the other carriageway is singly reinforced, and the remainder is reinforced with two layers of 7·88 lb. per sq. yd. of fabric, the bottom layer being 2½ in. from the bottom of the slab. The latter is in accordance with the Ministry of Transport specification.

Expansion joints are at 150 ft. intervals, with a tolerance of ± 25 ft., and there are no inter-



The road slab has been placed in two layers, each by a separate train of machines comprising one spreading and one finishing machine. The top surface is sprayed with a resin compound to ensure little change in water content during curing.


1'. 6"
2'. 0"
6'. 0"
6'. 0"
24'. 0"
Variable Minimum
10'. 0"
24'. 0"
10'. 0"
Crossfall 1 in 40
Crossfall 1 in 50
Crossfall 1 in 50
Crossfall 1 in 40
1'. 0"
1'. 0"
Slope 2:1
2" × 6" Pre-cast Edging
½" Dia. Tie Bars 3'. 6" Long at 2'. 6" Centres
11'. 6"
Mesh Reinforcement 14·27 Lb. per Sq. Yd.
All Verges Soiled and Seeded
Thorn Hedge
Slope 2:1
Open Ditch
6" Dia. Field Tile in Rubble-Filled Drain
½" Cold Asphalt Wearing Course
2" Tarmacadam Base Course
3" Layer of Shale or Ashes
4" Ballatint White Line
9" Dia. Surface Water Drain
Longitudinal Joint Groove Sawn in Concrete and Filled with Rubber Bitumen Sealing Compound
7" × 4" Pre-cast Kerb
10" Air Entrained Concrete Carriageway Brush Finished
6" Minimum Layer of Burnt Shale Sealed with Hot Tar Spray and ½" Chippings
1" Minimum Layer of Approved Fine Material
9" Dia. Surface Water Drain
Timber Post and Wire Protective Fence
(4426.A.)
"ENGINEERING"

Cross-section of the Longton by-pass. Full use of mechanical plant has enabled the 26 ft. road slabs to be placed at the rate of 500 ft. per day.

mediate contraction joints. The joint filler is 8½ in. deep and the sealing groove 1½ in. deep. At the joint at the end of a day's work a sponge rubber fillet is placed on top of the filler for the vibrator to pass over, thus ensuring full compaction to the end of the slab. On recommencement of work, the joint filler is concreted over and the fillet groove later sawn out mechanically. At intermediate expansion joints the machine concretes over the joint filler material and the sealing groove is subsequently sawn out. The longitudinal joint, 1¾ in. deep, is mechanically sawn. Good curing of the concrete is enhanced by spraying the surface with a resinous compound and provision is made for covering with tents when weather conditions are unfavourable. A daily progress of 500 ft. of carriageway has been attained.

The cycle track is in concrete, and the footways are finished in fine cold asphalt. Side road connections are laid on pre-mixed waterbound macadam, and are surfaced with bituminous macadam.

The Cement and Concrete Association have co-operated closely in the design and are providing a wet surface profilometer to measure irregularities in the finished surface.

Work commenced in July, 1956, and by the end of February, 1957, in spite of the heavy rainfall during the preceding summer and autumn, most of the earthworks, drainage and laying of the sub-base and the abutments and wing walls of the bridge were completed. Side-road alterations were also almost completed. Slab concreting began in April last and the work should be completed in October, 1957. The contractors are Tarmac Limited, Wolverhampton, and the tender amounts to £451,240.

PRESTON MOTORWAY: FLEXIBLE CARRIAGEWAYS

Progress on the Preston Motorway is not so advanced as on the Longton by-pass, for preliminary work only began in June of last year. Ultimately, however, it will provide dual three-lane carriageways designed for a vehicle speed of 70 m.p.h. The standards laid down for such roads by the Ministry of Transport and Civil Aviation include the following:

Straights: minimum 400 yd.; maximum 1,000 yd.

Minimum sight line: 650 ft.

Minimum radius of horizontal curves: 2,865 ft. (2 deg.).

Maximum gradient: 3½ per cent. generally, though 5 per cent. permitted in hilly country.

Maximum rate of change of centripetal acceleration on transition curves: 1 ft. per sec.^{2} per sec.

Although many and varied preliminary works were undertaken between June of last year and spring, 1957, no major excavations were begun. Recently, however, mass excavation has been started in the Ribble Valley area, at Samlesbury, where draglines, bulldozers and tractor scrapers have been used to reduce the surface to a workable gradient through the north and south escarpments on either side of the valley. At one point, at the crest of the southern escarpment, the cut is some 600 ft. wide.

Several of the principal bridges have been commenced, of which the largest is that which will carry the motorway over the River Ribble and the existing A.59. The bridge is designed with three spans, of 120 ft., 180 ft. and 120 ft., giving an overall length of 420 ft.; the width between parapets is 94 ft. The deck construction will consist of eight continuous steel box girders with curved soffits, the roadway being carried on a reinforced-concrete deck slab. The abutments and wing walls, which are on piled foundations and are nearing completion, and the piers (also piled) will be faced with ashlar masonry. Fabrication of the steelwork is well in hand and much of the superstructure has already reached the site. Of the other bridges, some will be basically steel structures with concrete slab decks but several will make use of prestressed concrete. Some of the pre-cast members are factory made but some are being made on site.

The motorway itself will have a flexible carriageway designed to the 2,000 wheel load curve of the Ministry's specification. The soil types found along the route are chiefly clays of varying strengths and the depth of construction will depend on the sub-grade at any given point, the thickness of the shale or slag sub-base being varied to suit. A 9 in. thickness of pre-mixed waterbound macadam will be laid over the sub-base, followed by a 2½ in. tarmacadam base course with a ¾ in. cold asphalt surfacing. The whole of this construction will be carried out mechanically using local materials. The principal contractor for the Preston by-pass, as for the Longton by-pass, is Tarmac Limited, and the sub-contractor for bridges is Leonard Fairclough Limited, Adlington, Near Chorley. The gross total of this tender is £2,432,360.

For both the projects described above the Lancashire County Council are acting as agents of the Ministry of Transport and Civil Aviation. The county surveyor and bridgemaster for the county, under whose responsibility the work is being undertaken, is Mr. James Drake, M.I.C.E.

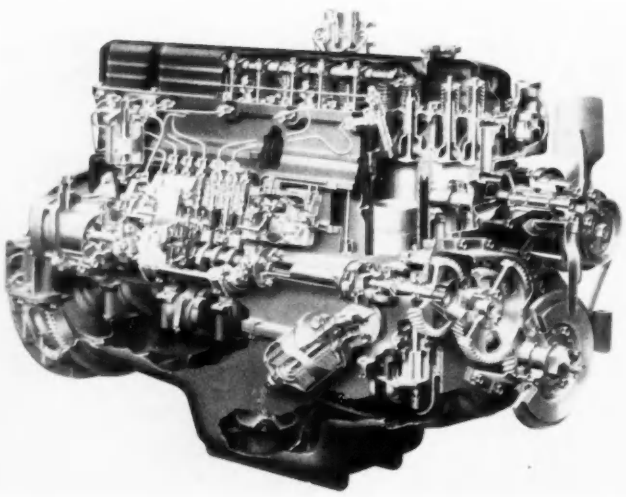
NEW FORD LORRIES AND ENGINES

Last week the Ford Motor Company announced two new additions—a six cylinder Diesel engine of 108 b.h.p. (gross) and a six cylinder petrol engine of 115 b.h.p. gross. At the same time, they exhibited some new lorries—the "Thames Traders"—ranging from 30 cwt. to 7 tons capacity using both the earlier four cylinder engines, and the new six cylinder models.

Many of the engine parts for the six cylinder models are also common to the four cylinder versions, thus simplifying the spares position. In the Diesel version, shown in the illustration, the exhauster for the auxiliaries is driven by an extension of the fuel pump drive. Direct injection is used, and the exhaust valves are caused to rotate. At 1,500 r.p.m. the gross torque is 252 lb.-ft. and the output of 108 b.h.p. (100 b.h.p. net) is attained at 2,500 r.p.m. The torque curve is flat over a wide speed range, exceeding 220 lb.-ft. from 1,750 to 2,250 r.p.m. The six cylinder petrol engine has the same gross torque of 252 lb.-ft. at 1,500 r.p.m. and reaches 115 b.h.p. (110 net) at 2,800 r.p.m. Wet cylinder liners are used on both types, and seven-bearing crankshafts.

The new range of vehicles are all fitted for forward control. Other design features aim at comfort, good visibility, and ease of maintenance. Power steering is an optional extra. The engine cowling which projects into the cab is double-skinned and insulated with glass fibre. The walls and roof of the cab can also be insulated, and there is provision for the through passage of cooling air. Foam rubber has been used for the seats. Alternative wheelbases are available.

The drive is through a hydraulically operated single-dryplate clutch to a four speed gearbox having synchromesh on all but the first gear. A two-piece open shaft drives the differential and a hypoid final drive is incorporated. The rear axle is fully floating. The hydraulic brakes are of the two-leading-shoe type with vacuum assistance in all models from three tons upwards. As mentioned earlier, ease of maintenance has been a prime point; all items requiring a daily check can be reached by raising the hood. The injectors and pump can be serviced by lifting off the cowling and most engine repairs can be carried out *in situ*. The removal of engine and gearbox complete is quite simple, however, and was carried out by a team of three (using the special trolley) in under four minutes. In fact from stopping the engine to restarting it, after it had been removed and replaced, took just under ten minutes. It is equally simple to remove the gearbox or the differential.



The range of commercial vehicle engines made by the Ford Motor Company now include six-cylinder Diesel and petrol models. The former, rated at 108 b.h.p., is shown here.

Concurrently with the new engines, there is a new range of forward control lorries, from 30 cwt. to 7 tons capacity. Alternative wheelbases are available for each model.

TOWING TROUBLES

While we spend a smaller proportion of our national income on road construction than any other European country, the British Government continues with traditional methods, trying to solve Europe's worst traffic problem by abolishing the traffic. The recent campaign by the Metropolitan police, who are towing away vehicles parked where they cause obstruction, is designed along with parking meters, to frighten a large number of people into giving up the use of their cars, and taking their place meekly in the queues for overpriced and overcrowded public transport. The British political minds seem to be wilfully blind to the fact that a car, like any other machine, is an investment which can only pay dividends by being used.

The police seem to be removing cars by lifting the front wheels and towing them away with their rear wheels on the ground. This may well lead to expensive damage to cars with modern transmissions. On an automatic gearbox such as the HydraMatic which is lubricated by two oil pumps, one of which is driven by the engine, towing may cause extensive damage to parts which are forced to revolve with insufficient lubrication. Many American manufacturers insist that their cars with automatic transmissions must not be towed unless the propeller shaft is disconnected: Rolls-Royce advise against towing more than a very short distance when cars are fitted with their automatic transmission and Daimler place a limit of 5 miles for towing of cars fitted with their fluid coupling and planetary gearbox; a distance which may well be exceeded by the police if the campaign has to be an extensive one. However, Borg-Warner state that their automatic transmission will take no harm from being towed any distance.

The Paris police take no risks in this respect. They put the car on a four-wheeled low-loading trolley and carry it away.

★ ★ ★

JAGUAR XK150 IN PRODUCTION

Disc Brakes, and Choice of Three Transmissions

Not only have Jaguar succeeded in resuming the normal production rate of 350 cars per week; they have also managed to bring two new models into production since the disastrous fire of February. The first was the 3·4 litre saloon, the second is the XK150 announced last week. This latest model is a development of the series which began with the XK120 in 1948, since when 20,500 of the XK120 and the XK140 have been built. Nine years ago, the easy 100 m.p.h. of the XK120 was considered sensational in a moderately priced sports car, but ideas on speed have evolved so rapidly that the latest and still faster version is sold primarily as a fast touring car, with choice of two body styles, coupé and convertible. It may be assumed that an open roadster will eventually be added to the range, but the real competition car is now the D-type and its derivative the XK-SS, with a maximum speed nearer 150 than 100 m.p.h.

The chassis of the XK150 is basically that of the 140 with the addition of Dunlop disc brakes on all four wheels, assisted by vacuum servo. The power unit is that of the Mark VIII saloon, giving the same power as the optional high-compression version of the 140 unit, and slightly higher torque, at lower engine speeds. This, coupled with the smoother shape of the body-work, should offset a weight increase of about 55 lb. for the coupé and 44 lb. for the convertible. The cylinder head has the larger valves first used on the C-type sports model, but with the existing port sizes so as to concentrate the performance improvement in the middle ranges. Maximum power is 210 b.h.p. at 5,500 r.p.m. and maximum torque of 215 lb.-ft. is produced at 3,000 r.p.m.

There is a choice of three transmissions; standard is the four-speed synchromesh gearbox. This can also be supplied with Laycock de Normanville overdrive, or the car can have the Borg-Warner automatic torque converter transmission, with the special Jaguar modification permitting the driver to hold it in intermediate gear and preventing unwanted changes into top when going into a corner quickly.

The bonnet has been redesigned to line up with a larger grille, and the door pressings have been re-tooled to give a higher waistline, which increases the interior width at shoulder level by 4 in. There are two separate front seats and two small occasional seats in the rear. Other body features are a wrap-round windscreen and much larger rear window.

NOTICES OF MEETINGS

Association of Supervising Electrical Engineers

LONDON
Annual General Meeting. North West London Branch. Century Hotel, Forty-avenue, Wembley Park. Mon, June 3, 7.30 p.m.
Annual General Meeting. West London Branch. 134 King-street, Hammersmith, W.6. Tues., June 4, 7 p.m.
Annual General Meeting. North London Branch. 677 Green Lanes, Harringay, N.4. Wed., June 5, 7.15 p.m.
Annual General Meeting. South London Branch. Half Moon Hotel, Broad Green, Croydon. Fri., June 7, 7.15 p.m.

BOURNEMOUTH
"Spot Welding," by C. G. Aldridge. Bournemouth Branch. Grand Hotel, Firvale-road, Bournemouth. Tues., June 4, 8 p.m.

CARDIFF
Annual General Meeting. South Wales Branch. Angel Hotel, Westgate-street, Cardiff. Tues., June 4, 7 p.m.

HALIFAX
Annual General Meeting. Halifax Branch. Crown Hotel, Horton-street, Halifax. Wed., June 5, 7.30 p.m.

LEEDS
Annual General Meeting. Leeds Branch. Great Northern Hotel, Leeds. Mon., June 3, 7 p.m.

LIVERPOOL
Annual General Meeting. Liverpool Branch. Liverpool Engineering Society, 9 The Temple, 24 Dale-street, Liverpool. Fri., June 7, 6.30 p.m.

LUTON
Annual General Meeting. Luton Branch. Chamber of Commerce, George-street West, Luton. Tues., June 4, 7.30 p.m.

MANCHESTER
Annual General Meeting. Manchester Branch. Engineers' club, Albert-square, Manchester. Wed., June 5, 7 p.m.

NOTTINGHAM
Annual General Meeting. Nottingham Branch. Mechanics' Institution, Trinity-square, Nottingham. Wed., June 5, 7.15 p.m.

PRESTON
Annual General Meeting. Preston Branch. R.A.F.A. Club, East View, Preston. Wed., June 5, 7.30 p.m.

SHEFFIELD
Annual General Meeting. Sheffield Branch. Royal Victoria Station Hotel, Sheffield. Mon., June 3, 7.30 p.m.

Building Centre

LONDON
Film: "The Yorkshire Way with Water," exhibited by Yorkshire Copper Works Ltd. Wed., June 5, 12.45 p.m.
Films on industrial lighting and catering equipment, exhibited by the British Electrical Development Association. Wed., June 12, 12.45 p.m.

Chemical Engineering Group

LONDON
"Granulation," by W. C. Peck. Society of Chemical Industry, 14 Belgrave-square, S.W.1. Tues., June 11, 5.30 p.m.

Chemical Society

LONDON
"The Vapour Pressure of Anhydrous Copper Nitrate, and its Molecular Weight in the Vapour State," by C. C. Addison and B. J. Hathaway; and other papers. Thurs., June 6, 7.30 p.m.

Combustion Engineering Association

LONDON
"Coal: Some Forecasts," by R. J. Moffat. London Region. St. Ermin's Hotel, Caxton-street, Westminster, S.W.1. Wed., June 12, 10.30 a.m.

CARDIFF
"The Reduction of Smoke and the Efficient Control of Combustion by Instrumentation," by W. R. L. Kent, at 10.30 a.m.
"The Effect of Coal Characteristics on the Operation of Mechanical Stokers," by D. C. Gunn, at 2.30 p.m. Welsh Region. Park Hotel and Whitehall Rooms, Cardiff. Wed., June 19.

Engineers' Guild

EDINBURGH
Luncheon Meeting. Speaker: Emlyn Jones, chief road engineer, Scottish Home Department. Scottish Liberal Club, 109 Princes-street, Edinburgh. Mon., June 10, 12.30 for 12.45 p.m.

Incorporated Plant Engineers

LONDON
"The Training of Plant Engineers," by J. Wilson. London Branch. Royal Society of Arts, John Adam-street, Adelphi, W.C.2. Tues., June 4, 7 p.m.*

CHESTER
"New Developments in Chemical Engineering Materials," by E. Warde. Merseyside and North Wales Branch. Stafford Hotel, City-road, Chester. Thurs., June 20, 7.15 p.m.

MANCHESTER
"Air Compressor Maintenance and Installation, and Ancillary Equipment," by W. McMillan. Manchester Branch. Engineers' Club, Albert-square, Manchester. Tues., June 4, 7.15 p.m.

Institution of Civil Engineers

LONDON
Annual General Meeting. Tues., June 4, 5.30 p.m.*

Institution of Electrical Engineers

CATTERICK
Demonstration of army wireless and line equipment, at 3.30 p.m. Paper on "The Application of Junction Transistors to Telecommunication and Control Equipment," by E. Wolfendale, at 6.15 p.m.* North Midland Centre. Headquarter's Mess, School of Signals, Catterick, Yorkshire. Tues., June 4.

Institution of Engineers and Shipbuilders in Scotland

GLASGOW
Centenary Celebrations, Tues., June 25, to Thurs., June 27.
Presidential Address by Sir Harold E. Yarrow, Bt.; "A Short Biography of the First President, Professor W. J. Macquorn Rankine," by Professor J. Small; and "Nuclear Power for Ship Propulsion," by Dr. S. L. Smith and Dr. J. E. Richards, at 10 a.m. Various works visits in the afternoon. Banquet, in St. Andrew's Halls, Granville-street, Glasgow, at 7 p.m. Tues., June 25.
All-day excursion to the Firth of Clyde, Wed., June 26.
All-day works visits and excursions. Reception by the Lord Provost of Glasgow, in the City Chambers, George-square, Glasgow, at 7.30 p.m. Thurs., June 27.

Institution of Mining and Metallurgy

LONDON
"Mechanisms of Collector Adsorption and Dynamic Attachment of Particles to Air Bubbles as Derived from Surface-Chemical Studies," by J. Leja; "Flotation of Soluble Salts," by J. Rogers; and "The Assessment of Flotation Results," by J. C. Nixon and D. N. Moir. Geological Society's apartments, Burlington House, Piccadilly, W.1. Thurs., June 20, 5 p.m.*

Institution of Naval Architects

LONDON
"Further Experiments on Sideways Launching—Series 2 and 3," by D. J. Doust and E. MacDonald. Thurs., June 6, 4.45 p.m.*

Royal Meteorological Society

LONDON
"Airflow Over an Isolated Hill," by R. S. Scorer; "Waves in the Lee of an Isolated Hill," by R. S. Scorer and M. Wilkinson; "Airflow Over Mountains: the Lee-Wave Amplitude," by G. A. Corby and C. E. Wallington. Wed., June 19, 5 p.m.*

Royal Society

LONDON
"The Mechanical Behaviour of Single Crystals of Metals, in Particular, Copper," by Dr. E. N. da C. Andrade and D. A. Aboav; and "Dislocations and Stacking Faults in Stainless Steel," by M. J. Whelan, P. B. Hirsch, R. W. Horne and W. Bollmann. Thurs., June 13, 4.30 p.m.*

Royal Society of Health

LONDON
"The Effects of Radiation on the Individual," by Dr. F. G. Spear. Wed., June 12, 2.30 p.m.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this column should reach the Editor not later than Monday morning in the week preceding the date of the meeting.

* An asterisk is placed where it is understood that tea is available prior to the time stated.

Association of Supervising Electrical Engineers, 23 Bloomsbury-square, London, W.C.1. (LANgham 5927.)
Building Centre, 26 Store-street, London, W.C.1. (MUSeum 5400.)
Chemical Engineering Group, 16 Belgrave-square, London, S.W.1. (BELgravia 3647.)
Chemical Society, Burlington House, Piccadilly, London, W.1. (REGent 0675.)
Combustion Engineering Association, 6 Duke-street, St. James's London, S.W.1. (WHItehall 5536.)
Engineers' Guild, 78 Buckingham-gate, London, S.W.1. (ABBey 7315.)
Incorporated Plant Engineers, 12 The Parade, Solihull, Warwickshire. (Solihull 1111.)
Institution of Civil Engineers, Great George-street, London, S.W.1. (WHItehall 4577.)
Institution of Electrical Engineers, Savoy-place, Victoria-embankment, London, W.C.2. (TEMple Bar 7676.)
Institution of Engineers and Shipbuilders in Scotland, 39 Elmbank-crescent, Glasgow, C.2. (Central 5181.)
Institution of Mining and Metallurgy, 44 Portland-place, London, W.1. (LANgham 3802.)
Institution of Naval Architects, 10 Upper Belgrave-street, London, S.W.1. (SLOane 4622.)
Royal Meteorological Society, 49 Cromwell-road, South Kensington, London, S.W.7. (KENsington 0730.
Royal Society, Burlington House, Piccadilly, London, W.1. (REGent 3335.)
Royal Society of Health, 90 Buckingham Palace-road, London, S.W.1. (SLOane 5134.)

FORTHCOMING EXHIBITIONS AND CONFERENCES

This list, arranged chronologically, appears in the last issue of each month. Events appearing for the first time, and alterations of dates, places, etc., are indicated by an asterisk (*). Particulars of exhibitions and conferences not included below may have appeared in ENGINEERING, *March 29, page 414; or April 26, page 542. Organisers are invited to send to the Editor particulars of coming events as soon as arrangements are made.*

Printing Industries and Allied Trades, International Exhibition.—Sat., June 1, to Sun, June 16, in Lausanne. Offices: 6 Avenue Mon-Repos, Lausanne, Switzerland.

Barcelona Samples Fair, 25th International.—Sat., June 1, to Thurs., June 20, at Barcelona. Apply to the Spanish Tourist Service, 4 West Halkin-street, Belgrave-square, London, S.W.1. Tel. SLOane 6124.

***Association Technique Maritime et Aéronautique, 56th Meeting.**—Mon., June 3, to Fri., June 7, at the Maison de la Chimie, 28 bis, Rue Saint-Dominique, Paris 7e. Papers on naval and aeronautical subjects will be discussed. Offices of the Association, at 1 Boulevard Haussmann, Paris 9e, will be moved to 47 Rue de Monceau, Paris 8e, as from June 25.

World Power Conference Sectional Meeting.—Wed., June 5, to Tues., June 11, followed by study tours. Trade Unions' Building, Belgrade, Yugoslavia. Apply to the British National Committee, 201 Grand Buildings, Trafalgar-square, London, W.C.2. Tel. WHItehall 3966.

Technical Writers' Institute, Convention.—Mon., June 10, to Fri., June 14, at the Rennsselaer Polytechnic Institute, Troy, New York, U.S.A. Organised as an aid to the profession of technical writing. Apply to Mr. Jay R. Gould, Director, at the above address.

Three Counties Agricultural Show.—Tues., June 11, to Thurs., June 13, at Hartpury, Gloucester. Organised by the Three Counties Agricultural Society, Berrington House, 2 St. Nicholas-street, Hereford. Tel. Hereford 3969.

Safety and Factory Efficiency Exhibition.—Fri., June 14, to Fri., June 21, at Bingley Hall, Birmingham. Organised by Birmingham and District Industrial Safety Group, Industrial Safety Training Centre, 22 Summer-road, Birmingham 27.

American Society for Testing Materials, Annual Meeting.—Sun., June 16, to Fri., June 21, at Chalfonte-Haddon Hall, Atlantic City, New Jersey, U.S.A. Organised by the American Society for Testing Materials, 1916 Race-street, Philadelphia 3, Pennsylvania, U.S.A.

Bordeaux International Trade Fair, 36th.—Sun., June 16, to Mon., July 1, at Bordeaux. *Agents:* Auger and Turner Group Ltd., 40 Gerrard-street, London, W.1. Tel. GERrard 6671.

Electrical Power Convention Exhibition.—Mon., June 17, to Fri., June 21, at Devonshire Park, Eastbourne. Organised by the British Electrical Development Association, 2 Savoy-hill, London, W.C.2. Tel. TEMple Bar 9434.

***Internal Combustion Engine Congress, Fourth International.**—Mon., June 17, to Tues., June 25, at Zürich. Theme: "Supercharged Diesel Engines and Combustion Turbines in Various Spheres—Marine, Traction and in Power Stations—Research Work, Results and Future Prospects." Apply to Mr. C. C. M. Logan, secretary, British National Committee, 6 Grafton-street, London, W.1. Tel. HYDe Park 5107. (Additional information.)

Business Efficiency Exhibition.—Mon., June 17, to Thurs., June 27, at Olympia, London, W.14. Organised by the Office Appliances and Business Equipment Trades Association, 11-13 Dowgate-hill, Cannon-street, London, E.C.4. Tel. CENtral 7771.

Welding Conference, British Commonwealth.—Mon., June 17, to Sat., June 29, in London and at Saltburn-by-the-Sea. Organised by the Institute of Welding, 29 Park-crescent, London, W.1. Tel. LANgham 7488.

***Buildings and Structures in Concrete, Photographic Exhibition of.**—Mon., June 17, to Fri., July 5, at the Building Centre, 26 Store-street, London, W.C.1. Organised in celebration of the 25th anniversary of its formation, by the Reinforced Concrete Association, 94-98 Petty France, London, S.W.1. Tel. ABBey 4504.

Royal Highland Agricultural Show.—Tues., June 18, to Fri., June 21, at Dundee. Organised by the Royal Highland and Agricultural Society of Scotland, 8 Eglington-crescent, Edinburgh 12. Tel. Edinburgh Central 6106.

***Institute of British Foundrymen, Annual Conference.**—Tues., June 18, to Fri., June 21, at Harrogate, Yorkshire. Organised by the Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester 3. Tel. Blackfriars 6178.

Institution of Civil Engineers, Conversazione and Exhibition.—Wed., June 19, at the Institution building, Great George-street, London, S.W.1. Tel. WHItehall 4577.

Welding and Cutting Exhibition and Conferences.—Sun., June 23, to Wed., July 3, Exhibition on the theme of "Welding in Production and Application," at Essen. Tues., June 25, to Fri., June 28, Conference of the Deutscher Verband für Schweisstechnik E.V. (German Association of Welding) on the theme of "Improvement in Efficiency and Productivity by Welding," at Essen. Sat., June 29, to Sat., July 6, annual assembly of the International Institute of Welding, with symposium on "Metallurgy of Welding," at Essen. Apply to the Gemeinnützige Ausstellungsgesellschaft m.b.H. Norbertstrasse 2, Essen.

Trieste International Trade Fair.—Sun., June 23, to Mon., July 8, at Trieste. Apply to the Italian Chamber of Commerce for Great Britain and the Commonwealth, 652 Grand Buildings, Trafalgar-square, London, W.C.2. Tel. WHItehall 5521.

Commercial and Scientific Exhibition.—Mon., June 24, to Wed., June 26, at the Show Mart, Montreal. Held in conjunction with the 23rd Congress of the Catholic Hospitals of the Province of Quebec. Apply to the Comité des Hôpitaux de Quebec, 325 Chemin Sainte-Catherine, Outremont, Montreal 8, Canada.

Exchange of Management Information, 11th International Conference.—Mon., June 24, to Fri., June 28, in Paris. Apply to the British Institute of Management, 8 Hill-street, London, W.1. Tel. GROsvenor 6000.

Housewares Show, Second International.—Mon., June 24, to Fri., June 28, in the Coliseum, New York. Organised by the Housewares Shows Corporation, 19 West 44th-street, New York 36, U.S.A.

Agricultural Fair, Sixth International.—Mon., June 24, to Sat., June 29, at Utrecht. *Agent:* Mr. W. Friedhoff, 10 Gloucester-place, London, W.1. Tel WELbeck 9971.

Institution of Engineers and Shipbuilders in Scotland: Centenary Meeting.—Tues., June 25, to Thurs., June 27, in Glasgow. Apply to the secretary of the Institution, 39 Elmbank-crescent, Glasgow, C.2. Tel. Glasgow Central 5181.

***Electronics in Automation, Convention.**—Wed., June 26, to Mon., July 1, at the Cavendish Laboratories, The University, Cambridge. Organised by the British Institution of Radio Engineers, 9 Bedford-square, London, W.C.1. Tel. MUSeum 1901.

Bond and Crack Formation in Reinforced Concrete, RILEM Symposium.—Thurs., June 27, to Sun., June 30, in Stockholm. Apply to the organising secretary, RILEM Symposium, c/o Cement and Concrete Institute, Stockholm 70, Sweden.

Electronics in Automation, Convention.—Thurs., June 27, to Mon., July 1, at King's College, Cambridge. Organised by the British Institution of Radio Engineers, 9 Bedford-square, London, W.C.1. Tel. MUSeum 1901.

Indonesia International Trade Fair.—Thurs., June 27, to Tues., Aug. 6, at Surabaya. Organised by the National Board of Indonesian Exhibitions, P.O. Box No. 2444, Djakarta, Indonesia.

Automatic Production: Change and Control, Conference.—Sun., June 30, to Wed., July 3, at Harrogate, Yorkshire. Organised by the Institution of Production Engineers, 10 Chesterfield-street, London, W.1. Tel. GROsvenor 5254.

***Office Machine Dealers' Show.**—Sun., June 30, to Wed., July 3, at the William Penn Hotel, Pittsburg. Organised by the National Office Machine Dealers' Association, 1542 Hillhurst-avenue, Los Angeles 27, California, U.S.A.

Concrete Shell Roof Construction, Second Symposium on.—Mon., July 1, to Wed., July 3, at the Ingeniorenes Hus, Oslo, Norway. Organised by the Norwegian Engineering Society in co-operation with the Norwegian Concrete Association. Apply to the Cement and Concrete Association, 52 Grosvenor-gardens, London, S.W.1. Tel. BELgravia 6661.

Occupational Health, Twelfth International Congress on.—Mon., July 1, to Sat., July 6, at Helsinki. Apply to the secretary, organising committee, Haartmaninkatu, 1, Helsinki, Finland.

Atomic Energy Exhibition, International.—Mon., July 1, to Mon., Sept. 16, at Schiphol Airport, near Amsterdam, Holland. Organised with the support of the Dutch Government, the Amsterdam City Council, and the Amsterdam Chamber of Commerce. Secretariat offices: 37 Roemer Visscherstraat, Amsterdam. *Agents:* Galitzine and Partners Ltd., 17 Victoria-street, London, S.W.1. Tel. ABBey 4013.

Royal Agricultural Show.—Tues., July 2, to Fri., July 5, at Costessey, Norwich. Organised by the Royal Agricultural Society of England, 35 Belgrave-square, London, S.W.1. Tel. BELgravia 5323.

Physical Problems of Colour Television, International Symposium.—Tues., July 2, to Sat., July 6, in Paris. Organised by the International Union of Pure and Applied Physics, the Société Française des Radioélectriciens and the Société Française des Ingénieurs et Techniciens du Vide. Apply to the secretary, Colloque International sur les Problèmes de la Télévision en Couleurs, Conservatoire National des Arts et Métiers, 292 Rue Saint-Martin, Paris, 3e.

***Calgary Exhibition and Stampede.**—Sat., July 6, to Sat., July 13, at Calgary, Alberta. General trade fair organised by Calgary Exhibition and Stampede Ltd., Administrative Building, Exhibition Grounds, Calgary, Alberta, Canada.

***Lamp Show.**—Sun., July 7, to Fri., July 12, in New York. Exhibition of electrical and radio apparatus. Communications to Mr. George F. Little, 220 Fifth-avenue, New York 1, U.S.A.

Solvent Effects and Reaction Mechanism, Symposium.—Mon. and Tues., July 8 and 9, in the Queen's Building, Queen Mary College, London, E.1. Organised by the Chemical Society, Burlington House, Piccadilly, London, W.1. Tel. REGent 0675.

***Northern Rhodesia Industrial and Commercial Show.**—Mon., July 8, to Sat., July 13, at Ndola. Organised by the Northern Rhodesia Industrial and Commercial Show Society, Ltd., P.O. Box 646, Ndola, Rhodesia.

Navigation Congress, 19th International.—Mon., July 8, to Sat., July 20, at the Institution of Civil Engineers, Great George-street, London, S.W.1. Sponsored by the Permanent International Association of Navigation Congresses. Apply to Mr. A. C. Morrison, secretary, British Organising Committee, at the Ministry of Transport and Civil Aviation, Berkeley Square House, London, W.1. Tel. MAYfair 9494.

Institution of Naval Architects, Summer Meeting.—Tues., July 9, to Thurs., July 11, in Bristol. Organised by the Institution of Naval Architects, 10 Upper Belgrave-street, London, S.W.1. Tel. SLOane 4622.

Great Yorkshire Agricultural Show.—Tues., July 9, to Thurs., July 11, at Harrogate. Organised by the Yorkshire Agricultural Society, Cliftonfield, Shipton-road, York. Tel. York 3102.

British Plastics Exhibition and Convention.—Wed., July 10, to Sat., July 20, at Olympia, London, W.14. Apply to British Plastics Exhibition, Dorset House, Stamford-street, London, S.E.1. Tel. WATerloo 3333.

***Recent Advances in the Chemistry of Terpenoid Compounds, Symposium.**—Thurs. and Fri., July 11 and 12, in the Chemistry Department, The University, Glasgow. Organised by the Chemical Society, Burlington House, Piccadilly, London, W.1. Tel. REGent 0675.

Materials for Nuclear Engineering, Conference.—Thurs. and Fri., July 11 and 12, at works of the Associated Electrical Industries Ltd., Aldermaston, Berks. Organised by the Physical Society, 1 Lowther-gardens, Prince Consort-road, London, S.W.7. Tel. KENsington 0048.

Electronics Exhibition and Convention, 12th Annual.—Thurs., July 11, to Sat., July 13, and Mon., July 15, to Wed., July 17, at the College of Science and Technology, Manchester. Organised by the Northern Division of the Institution of Electronics, 20 Buckingham-street, London, W.C.2. Apply to Mr. W. Birtwistle, 78 Shaw-road, Thornham, Rochdale, Lancs. Tel. Oldham Main 6661.

Building Plant Exhibition.—Mon., July 15, to Sat., July 20, at Heaton Park, Manchester. Organised by the Ministry of Works, Lambeth Bridge House, London, S.E.1. Tel. RELiance 7611.

***Edmonton Exhibition.**—Mon., July 15, to Sat., July 20, at Edmonton, Alberta. Organised by the Edmonton Exhibition Association, Ltd., Exhibition Grounds, Alberta, Canada.

***Industrial Engineering Exhibition.**—Mon., Aug. 5, to Sat., Aug. 10, at Melbourne. Apply to the Industrial Public Relations Service of Australia, 82 Toorak-road West, South Yarra, Melbourne, Victoria.

***Sydney Motor Show.**—Fri., Aug. 16, to Sat., Aug. 24, at the Royal Agricultural Society's Showground, Moore Park, Sydney. Organised by the Chamber of Automotive Industries of New South Wales, 75 William-street, Sydney.

***Izmir International Trade Fair.**—Tues., Aug. 20, to Fri., Sept. 20, at Izmir. Information from the British Chamber of Commerce of Turkey, Piyasa Han 602-606, Asirefendi Cad. 11/13, Istanbul, Turkey.

***Pacific National Exhibition.**—Wed., Aug., 21, to Mon., Sept. 2, in the Exhibition Park, Vancouver. Apply to Mr. Ben Williams, Exhibition Park, Vancouver, B.C., Canada.

***Canadian National Exhibition.**—Fri., Aug. 23, to Sat., Sept. 7, in Toronto. *Representative:* Mr. G. H. Ward, British Columbia House, 3 Lower Regent-street, London, S.W.1. Tel. WHItehall 2794.

***Operational Research, International Conference on.**—Mon., Sept. 2, to Fri., Sept. 6, at The University, Oxford. Object: to unify and extend the science of operational research. Organised jointly by the Operations Research Society of America, the Institute of Management Sciences, U.S.A., and the Operational Research Society of the United Kingdom. Apply to Dr. Thornton Page, Operations Research Office, 7100 Connecticut-avenue, Chevy Chase, Maryland, U.S.A., or to Mr. B. H. P. Rivett, hon. secretary, Operational Research Society of the United Kingdom, 2 Grosvenor-place, London, S.W.1.

***Business Efficiency Exhibition.**—Mon., Sept. 16, to Sat., Sept. 21 in Cape Town. Organised by the Cape Town Junior Chamber of Commerce, P.O. Box 204, Cape Town, South Africa.

***Association of Public Lighting Engineers, Annual Conference.**—Tues., Sept. 17, to Fri., Sept. 20, in the Town Hall, Torquay. Exhibition of street lighting apparatus and an open-air display of lamp columns and tower wagons in the Upton Valley Gardens. Organised by the Association of Public Lighting Engineers, 17 Victoria-street, London, S.W.1. Tel. ABBey 4281.

***Stationery and Office Equipment Show.**—Sat., Sept. 28, to Wed., Oct. 2, at the Conrad Hilton Hotel, Chicago. Organised by the National Stationery and Office Equipment Association, 750 Investment Building, Washington, D.C., U.S.A.

***Perth Royal Agricultural Show.**—Sat., Sept. 28, to Thurs., Oct. 3, at Perth. Organised by the Royal Agricultural Society, 9 Howard-street, Perth, Western Australia.

***Canadian National Material Handling Show and Conference.**—Mon., Sept. 30, to Fri., Oct. 4, at Montreal. Communications to Mr. E. Dupre, Northern Electric Co. Ltd., 150 Metropolitan Boulevard, Lachine, Quebec, Canada.

***National Cattle and Agricultural Machinery Fair.**—Early in October, at Quinta Normal, Santiago. Organised by the Sociedad Nacional de Agricultura, Tenderini 187, Santiago, Chile.

***Gas Council's Fifth Sales and Service Conference.**—Tues., Oct. 1, to Thurs., Oct. 3, at the Hotel Majestic, Harrogate, Yorkshire. General Theme: The Need for Training and Organisation in Salesmanship. Organised by the Gas Council, 1 Grosvenor-place, London, S.W.1. Tel. SLOane 4554.

***Lubrication and Wear, Conference.**—Tues., Oct. 1, to Thurs., Oct. 3, technical sessions in London. In addition, Mon., Sept. 30 and Fri., Oct. 4, will be devoted to whole-day and half-day excursions. Some of the papers will be re-discussed at subsequent meetings in Toronto and New York. Organised, with the collaboration of the American Society of Mechanical Engineers, by the Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, London, S.W.1. Tel. WHItehall 7476.

***Automatic Merchandising Convention and Exhibition.**—Sun., Oct. 13, to Wed., Oct. 16, at the Convention Hall, Philadelphia. Organised by the National Automatic Merchandising Association, 7 South Dearborn-street, Chicago 3, Illinois, U.S.A.

***Institute of Radio Engineers, Convention and Exposition.**—Wed., Oct. 16, to Fri., Oct. 18, at the Canadian National Exhibition Park, Toronto. Organised by the Institute of Radio Engineers, Canadian Section, 745 Mount Pleasant-road, Toronto 7, Ontario, Canada.

***Canada's Power Show.**—Mon., Oct. 21, to Thurs., Oct. 24, in the New Queen Elizabeth Building, Exhibition Park, Toronto. Organised by the Institute of Power Engineers, 199 Bay-street, Toronto, Ontario, Canada.

***Fisheries Exhibition, International.**—Mon., Oct. 21, to Sat., Oct. 26, at Lowestoft. Exhibition offices: Ludgate House, 110 Fleet-street, London, E.C.4. Tel. FLEet Street 6961.

***Algiers International Trade Fair, 17th.**—Fri., Oct. 25, to Mon., Nov. 11, in Algiers. Fair Offices: 3 Rue Jean-Rameau, Algiers, Algeria.

***National Protective Packaging and Materials Handling Exposition.**—Mon., Oct. 28, to Thurs., Oct. 31, in Atlantic City. Communications to Hanson and Shea Incorporated, 1 Gateway Centre, Pittsburgh, Pennsylvania, U.S.A.

***Atomic Show.**—Mon., Oct. 28, to Thurs., Oct. 31, at the Coliseum, New York. Organised by the Atomic Industrial Forum, 3 East 54th-street, New York 22, U.S.A.

***Measuring Instruments and Automation, International Congress and Exhibition (INTERKAMA).**—Sat., Nov. 2, to Sun., Nov. 10, at the Ehrenhof Exhibition Grounds, Dusseldorf. Organised by the Nordwestdeutsche Ausstellungs-Gesellschaft m.b.H. (NOWEA), Ehrenhof 4, Düsseldorf, Germany. (Additional information.)

***Canadian National Packaging Exposition, Sixth.**—Tues., Nov. 5, to Thurs., Nov. 7, in the Automotive Building, Canadian National Exhibition Park, Toronto. Organised by the Packaging Association of Canada, 1 St. Clair-avenue West, Toronto 7, Ontario, Canada.

Industrial Efficiency and Productivity Exhibition.—Tues., Nov. 5, to Sat., Nov. 16, at the City Hall, Deansgate, Manchester, Organised by Provincial Exhibitions Ltd., City Hall, Deansgate, Manchester. Tel. Deansgate 6363.

***BEAMA Publicity Conference.**—Thurs. and Fri., Nov. 7 and 8, at the Connaught Rooms, Great Queen-street, London, W.C.2. Attendance restricted to staffs of member-firms of BEAMA. Apply to the British Electrical and Allied Manufacturers' Association, 36 and 38 Kingsway, London, W.C.2. Tel. HOLborn 0502.

***Scottish Motor Exhibition.**—Fri., Nov. 8, to Sat., Nov. 16, at Kelvin Hall, Glasgow. Organised by the Scottish Motor Trade Association Ltd., 3 Palmerston-place, Edinburgh 12. Tel. Edinburgh Central 3643.

***Royal Agricultural Winter Fair.**—Fri., Nov. 15, to Sat., Nov. 23, at the Coliseum, Toronto. Offices: Royal Agricultural Winter Fair, Coliseum, Exhibition Park, Toronto, Canada.

***Bogota International Fair, Fourth.**—Fri., Nov. 22, to Sun., Dec. 8, at Bogota. Organised by the Corporacion de Ferias y Exposiciones, Edificio Avenida, Carrera 5a, No. 15-11, Bogota, Colombia.

In Parliament

DOUBLING NUMBERS OF UNIVERSITY STUDENTS

Much has been said and written lately on education problems and there have been discussions on various aspects of the subject in both Houses of Parliament. Last week, there was a further debate in the House of Lords, this time on the present situation with regard to university education.

Lord Pakenham (Labour), who called attention to the matter, said that, according to the best figures he had been able to obtain, from a UNESCO publication of 1955, enrolments for higher education in England and Wales, during the latest year then available, amounted to 156 per 100,000 of the population. In Russia, the comparative figure was 697, inclusive, however, of correspondence courses. In the United States, it was 1,783, or eleven times that of England and Wales. Was there, he asked, no further reason for disquiet in the fact that the Scottish figures were 294 per 100,000, or nearly twice as good as those for the southern half of Britain?

It was not only in respect of increases in the numbers of engineers and scientists, for whom the demand was most urgent, that the country had to think in much more ambitious terms than at present: if the universities were to serve the real needs of the nation there must be a widespread improvement. The Government had stated last November that the universities had already made proposals for increasing the number of students there from 84,000 in 1955, to 106,000 by the middle 1960's, and that, of this increase in numbers, some two-thirds would study science or technology. He understood that the universities had not put forward a higher figure than 106,000, because their past experience of Government sanctions, especially in regard to building, prevented them from being more sanguine.

The present total should be doubled. The target for the number of university students ten years from now should be not fewer than 176,000. Any lower figure would be rather shocking. All who were competent to benefit from university education should be given the opportunity to receive it. Time was much shorter than might be supposed. If there was to be a really big increase in the number of students, the building programme must be expanded considerably from 1960 onwards.

COMBATING SPECIALISATION

Nowadays, most educationalists, Lord Pakenham said, confessed themselves alarmed by the present degree of specialisation, but a number of them seemed disposed to accept as ineluctable the recognised fact that the general pattern of degree courses at English universities involved concentration in a relatively narrow field. They were sceptical about efforts to broaden the curriculum, such as were being made at North Staffordshire University College. The College was an inspiring experiment, full of brilliant promise. He would not reproduce the experiment on a national scale but he would insist that, in every university, every art student should take one paper in science, and every science student one paper in arts, preferably in English literature.

The pace towards specialisation was set by the terrific competition to win university scholarships. In the last resort, the whole mental life of the abler children in their last years at school was governed by the university scholarship examinations and, here, the universities must face their responsibilities more candidly than hitherto, and not put the blame on the schools.

Some 80 per cent. of university students in England and Wales were assisted by the State, of whom about one-quarter were State scholars. The remainder received awards from local authorities to cover all or part of their subsistence. One glaring defect in the present system was the wide variation among the different authorities in the making of these awards: variations that caused much irritation and suspicion, and, inevitably, some injustice. These differences must either be rapidly corrected or the grants system must be definitely centralised once and for all.

As an immediate reform, there were three proposals which he would suggest. First, the provision of subsistence awards to all who had secured places at the universities, but subject to a means test. Secondly, the raising of the income level below which the means test did not operate. In this connection, he would suggest raising the bottom level from £450 a year to £600 a year, at least. There should also be a more realistic grant towards the maintenance of students during vacations. Thirdly, the means test should be removed altogether from State scholarships.

FEAR OF MATHEMATICS UNFOUNDED

A certain fear of science and technology, which existed in the minds of students during their earlier years, was referred to by Viscount Cherwell, F.R.S. (Conservative). He felt that this fear existed because the students were in need of some mathematical knowledge and he was convinced that the fear was out of place. Anyone who could think logically could learn the sort of mathematics required for science, except, possibly, in the highest and most recondite developments of modern physics. If boys and girls found that they could not acquire such a knowledge of mathematics it must be due to bad teaching.

There was some anxiety concerning the next quinquennial grant for the universities. At Oxford, for example, the authorities would have to take on a considerable extra burden owing to the sudden cessation of conscription; yet it appeared that the new Government grant would not match even the amount that it had been explained would be required before these additional numbers were expected.

The average technologist or scientist knew the outlines of arts subjects, whereas the arts man usually knew nothing whatever of science or technology. The country should possess both universities of the ordinary type now existing and technological universities, such as the Massachusetts Institute of Technology, in which the main emphasis was on technological and scientific subjects, with the relevant ancillary arts subjects taking second place.

NEED FOR LEADERS IN MANY FIELDS

Replying to the debate, Lord Hailsham, the Minister of Education, pointed out that, in Britain, the university degree and entrance to a university were reserved for a much more specialised type of course than in other countries. If a true comparison were to be made with conditions in other countries, the great number of institutions here, in addition to the universities, which provided higher education, would have to be taken into account.

On behalf of the Government, he fully endorsed every word that had been said about the need for scientists and technologists. In Britain's complex society, the Government were trying to produce a whole range of leaders in all kinds of social, business and political activity, of which the technologists and scientists were a most important part, and a part of growing importance.

It was for the University Grants Committee to pronounce on the prospects of the University of Sussex. The Committee, for whom a new college at Brighton had special attractions, had the matter under active consideration. The decision must depend on whether the necessary facilities could be provided at a cost per place which compared reasonably with the cost of providing places elsewhere.

He was attracted by the suggestion that State scholarships could be treated differently from other university awards, but he was inclined to the view that he could not honourably or justly do so. To single out State scholars for special treatment would be administratively and conscientiously difficult, and, in practice, impossible to sustain. The cost of abolishing the means test for both classes of award would be £3 million a year, and not £800,000, as had been stated.

CRITICISMS OF ATOMIC REACTORS

The Prime Minister's attention was drawn by Captain G. R. Chetwynd (Labour) and Wing-Commander E. E. Bullus (Conservative) to the criticisms which had been made at a conference in Tokyo respecting British-type atomic-energy reactors. Mr. Harold Macmillan was asked what steps were being taken to counteract these comments, in view of their effect on Britain's oversea trade.

Mr. Reginald Maudling, the Paymaster-General, said he had been asked to reply. Reports had been received of the remarks made about reactors of the Calder Hall type at a Tokyo conference, organised jointly by the American and Japanese Atomic Energy Forums which were organisations of industrial firms concerned with atomic energy. The reactors at Calder Hall had gone into operation more smoothly and with far less trouble than was normally experienced in starting up a conventional power plant; and the reactor system continued to show great potentialities for further development. The Government would be glad to show any customers both the limitations and the potentialities of Calder Hall, which was the only nuclear power station in the world producing electricity on an industrial scale.

The best answer to criticism was to show what Britain had achieved, and which the critics had not.

Natural Gas Deposits in Britain

Relatively small quantities of natural gas have been found in Yorkshire and other parts of the country during the past few years but not in sufficient quantities for commercial exploitation. In this connection, Mr. Maudling told Mr. Albert Roberts (Labour) that a recent find at Trumfleet in Yorkshire required further investigation before the quantity available could be determined. The search was continuing.

Uranium Deposits in Britain

The Prime Minister was asked by Mr. Geoffrey Wilson (Conservative) whether, in the national interest and in spite of the expense involved, he would consider setting up an extraction plant to deal with native deposits of uranium. Mr. Macmillan said no: known deposits of uranium in the United Kingdom were insufficient to feed even the smallest treatment plant for a single year.

Servicing of Agricultural Machinery

According to an answer given by Mr. J. B. Godber, Joint Parliamentary Secretary to the Ministry of Agriculture, Fisheries and Food, to Mr. Tudor Watkins (Labour), contracts for servicing farmers' agricultural machinery have been dispensed with by the Welsh county agricultural committees of Caernarvon, Carmarthen, Flint, Glamorgan, Monmouth, Montgomery and Radnor. There was not sufficient information available to show the number of persons carrying out servicing contracts for farmers in these areas.

Wireless Developments in Scotland

Mr. Kenneth Thompson, the Assistant Postmaster General, informed Mr. Joseph Grimond (Liberal) that the British Broadcasting Corporation expected to open very-high-frequency sound broadcasting stations at Kirk o'Shotts during the coming autumn and at Rosemarkie next year. The television station of the Corporation at Rosemarkie would be ready later this year and the Independent Television Authority's station at Blackhill, Lanarkshire, would open on August 31. The Postmaster-General was also considering a recent proposal from the Corporation for a very-high-frequency sound and television station in the Orkneys. Such a station would also serve the north coast of Caithness, and would greatly improve the reception in those areas.

THE HUMAN ELEMENT

The Proper Study of Mankind

An international conference is to be held at Namur in July to be called the "International Congress for the Promotion of Labour and Workers." It is to meet in three sections and will have the blessing of the Minister of Labour and Social Security in Belgium. The three sections will study the sociology of labour, security and health of the worker and the labour sciences. The pragmatically minded British may wonder whether there are any of the latter to study.

There is a significant remark in the letter drawing attention to the congress. It says: "Thus it is that we are to-day witnessing the dawn of a new humanism; not that of physical and moral man but of a man as a potential agent of civilisation, of social progress and well-being." Presumably it is to be gathered that the worker in his working environment is an end in himself, a social phenomenon of ultimate significance. It will be interesting to see what kind of an intellectual pigeon hole is found for the merely moral man who has a simple urge to better himself and rise above his environment. At times it is difficult to see in exercises of this kind more than a complicated effort to justify the average man to himself in this the century of the Common Man. He is to be set within the framework of "scientific" laws and play his humble but dignified part in the Grand Design. Thinking on these lines seems to have much in line with keeping us all in our proper stations—which will doubtless please the squire and the intellectual but not a fairly large section of the British working class.

The Flicker of a Flame

Slowly, hesitantly, the trade unions are showing an interest in productivity and in the prospects of the industries in which their members are working. The Amalgamated Engineering Union has led the way. First it voted as its president Mr. W. J. Carron, a man keenly interested in productivity and determined not to trade in the long-term prospects of engineering workers for immediate gains in wages which could cripple their industry. Second, under Mr. Carron's leadership, the A.E.U. influenced the Confederation of Shipbuilding and Engineering Unions to accept certain conditions in return for a wage increase of 6½ per cent.

The unions have promised that no further applications for "increases in wages or differentials shall be submitted for at least one year." They also promised to use their influence to prevent unofficial stoppages, overtime bans, restrictions on output and earnings, and to facilitate the introduction and use of new machines and techniques. This is a public admission of union responsibility for higher productivity, and for wage stability, without parallel in the history of engineering. It is also an admission of the principle that an industry can only pay the wages it can afford, and that it is likely to afford less if constant wage increases prevent firms from quoting firm prices to their customers. In overseas markets this inability has in the past proved one of the major obstacles to higher exports, and perhaps the chief handicap in competing against Germans and other Continental firms.

It could be dangerous to read too much into the agreement just concluded. Its cost—£70 million for manual workers and £14 million for technical and clerical workers—is a major addition to the cost of manufacture. It leaves unsettled the dispute in the shipbuilding industry. It says nothing explicit about the claims for a 40 hour week, three weeks paid holiday, and other demands which the A.E.U. have decided to press this year. And the agreements to co-operate against restrictive practices have yet to be worked out. Yet it is evidence that deep down in trade unionism a consciousness exists of labour's responsibilities, and a realisation that workers' prospects and those of their industries are inseparable.

Pensions in the United States

Although organised labour in the United States started somewhat late in its collective bargaining with employers it has been gathering impetus rapidly of recent years. At a time when retirement pensions in this country are about to go through a period of public discussion, it is worth drawing attention to the recent trend of pensions agreements in the United States.

In recent years, between 10 and 20 per cent. of all wage negotiations have provided for the establishment or extension of a pensions scheme for operatives—not just for salaried personnel. Between 55 and 60 per cent. of union members eligible for social security benefits are now also covered by negotiated pensions. In the middle of 1955 a survey by the U.S. Department of Labour covering 17 large cities and 4½ million plant workers found that 61 per cent. of workers were covered by some kind of a pension scheme. There is thus a clear trend for all workers to be covered by negotiated retirement benefits.

Trends are somewhat similar to those in this country. The size of pensions is tending to increase and the contributed portion from employers is growing, due in particular to the larger number of schemes based on 100 per cent. employers' contributions. Change of job often carries with it rights to a portion of the pension and the number of years necessary to qualify for benefits is falling on the average. All-in-all, the pattern the world over is to put a growing burden on the younger generation to pay for the older generation's benefits out of current abstinence. Here is a redistribution of national incomes which is beginning to dwarf the transfer of purchasing power from the rich to the poor by heavy taxation.

National Wages Policy

Support for a national wages policy is coming from various trade-union sources. Last week the Transport Salaried Staffs Association annual conference produced two resolutions urging the introduction of a national pattern of wages and a national minimum wage. In an article published in the *Sunday Times*, Mr. Bob Edwards, M.P., general secretary of the Chemical Workers' Union, advocated a national minimum wage on the ground that "Britain's never-ending free-for-all over industrial wages" does tragic harm to our national economy. According to Mr. Edwards the main reason for this is that we have "a hopelessly out-of-date system for wage assessment and wage negotiation."

Whatever truth there is in such statements, and there is a great deal, little purpose can be served by small unions putting forward suggestions quite unacceptable to large unions. What is important is the growing realisation that the wage spiral is a threat to the workers' future. For when this becomes strong enough it leads to agreements which place productivity, labour costs and the prospects of industries in their proper relationship.

Apprenticeship for Clerks

A national apprenticeship scheme for commerce has been started under the auspices of the 100 chambers of commerce affiliated to the Association of British Chambers of Commerce in collaboration with the technical and commercial colleges. There is a slightly different arrangement for Scotland. The idea and the details of the scheme will repay study and details can be obtained from local Youth Employment Offices and from chambers of commerce affiliated to the national body.

The great danger from the point of view of employers and junior staff to-day is that the latter will become involved in routine clerical work which has limited outlets at the top unless some sort of qualification is obtained. Such an end is wasteful both in terms of immediate office overheads and in the end of office mechanisation.

The danger which is most difficult to guard against is that there is bound to be a break clause at the end of a certain period (as there is with this scheme) and the less keen will be anxious to take advantage of it. There is probably no way round this difficulty, except to screen applicants with the greatest possible care—both the youngsters and their parents.

Selling the Railways

The contrast between the Army's recruitment literature and life at the depot is one of the traditional music-hall jokes which never quite lie down and die. The difference between the recruiting officer's and the sergeant major's views of a private's daily round has lessons for other large organisation. British Railways is a case in point.

A very attractive booklet has recently been produced welcoming the new recruit—a good idea and well done. This is obviously the time for the railways to talk about themselves. At long last they have got capital to spend and they urgently need to attract good men for the railways of to-day and to-morrow, as brain and organisation take the place of brawn in large quantities at the lower end of the grades of railway staff and operatives. But this right approach sits ill with the publicity given at the end of last week to criticisms of office-working conditions made at T.S.S.A.'s conference. Tales of bad working conditions at main stations are readily believed despite recent steps to modernise them.

The fact is that the more the railways try to attract labour by selling themselves (which they must do) the quicker they must offer conditions which their competitors already have. It is a hard saying but true that the better the salesman, the quicker must he produce the goods.

Swords into Plough Shares

At the twelfth annual delegate conference of the Institution of Professional Civil Servants the general secretary's speech was much concerned with the need to raise the salaries of technical staff and to use the Royal Ordnance Factories in civil production. Both are interesting subjects but they are both better considered in terms of what the market wants than in terms of people's rights and the value of ready-made production units.

It is a basic fact which will colour all discussions about salaries of technical people over the next few years, no matter what complicated arguments are produced to cloak it, that demand exceeds supply. It is therefore quite wrong to say that technical staff, in the civil service or elsewhere, have a right to a certain level of remuneration or certain prospects for their careers. Rights do not enter into it, but scarcity or surplus does. In the same way, discussion about the possibility of using Government factories will get nowhere until it is shown that they are wholly efficient production units. Factories do not produce the right kind of goods at the right prices unless they have a sales force and a management which can assess changing prospects. Once again it is the market which should be watched not the unit.